Information for Mathematics Majors
Princeton University, Spring 2020

General Note

During the current period of COVID-19 sequestering and social distancing, the typical practice of in-person consultation with faculty needs to be replaced with other means of communication. We suggest that you e-mail the faculty member with whom you wish to speak, to establish the best way to continue the conversation. Similarly, rather than picking up forms in the department and hand-carrying them from office to office, we have moved to a process wherein forms will be received, approved, and returned as PDFs via e-mail. If you have any questions about this process, please e-mail Michelle Matel, the department's Undergraduate Administrator, at mmatel@princeton.edu.

Also note that social distancing and sequestering have required the department to cancel its daily tea, described below. When the situation allows us to resume this tradition, we will notify our departmental community.

Normally, Mathematics departmental courses and prerequisites should be taken for a grade. We still suggest this as the best option. We are looking for math majors who love to do math, even if their grades are not the best. However, for courses taken Spring 19/20 we will accept P/D/F credits.

People to Talk To

If you are interested in becoming a math major, please e-mail Dr. Mark McConnell (markwm@princeton.edu), the Junior Advisor, to review your courses and make plans. Other people to consult are the Director of Undergraduate Studies, Professor János Kollár (kollar@math.princeton.edu); and the Senior Advisor, Professor John Pardon (jpardon@math.princeton.edu). The Undergraduate Representative for PACM is Professor Ramon van Handel (rvan@princeton.edu); he should be consulted for questions about applied mathematics courses, the certificate program in applied mathematics, and the applied mathematics track in the Mathematics Department.

The Undergraduate Administrator, Michelle Matel (mmatel@princeton.edu), has responsibility for the records and administrative matters dealing with undergraduate mathematics courses and mathematics majors.

General Course Requirements

By the start of the junior year, mathematics majors are expected to have a background knowledge of calculus in one and several variables and of linear algebra, and to have had at least some experience with rigorous proofs and formal mathematical arguments. Here are some recommended sequences.

• The honors sequence 215–217–300 covers calculus and linear algebra more thoroughly and theoretically and serves as an introduction to some mathematical techniques and results that are background for further work.

• The accelerated honors sequence 216–218 covers roughly the same material in two semesters.

• The sequence 203–204 covers the basic background material in calculus and linear algebra. It should be supplemented by a proof course, typically 214 or 215.

• Another choice is 201–202–215.

• Many of the above possibilities can be mixed differently; please contact Mark McConnell if you have questions. It is not necessary for students who have had equivalent courses elsewhere to take these specific courses.

Mathematics majors must also meet the general University requirements for graduation. It is wise to get these requirements out of the way as early in your undergraduate years as possible, to leave freedom in the junior and senior years for courses in mathematics and other topics in which you aim to do advanced work. Mathematics majors are required to complete successfully a minimum of 31 courses for graduation, of which a minimum of 19 must be outside the Mathematics Department. Of these 19 courses, two can be from the list of 200-level prerequisite courses for the department.

Please note: students who take more than 12 courses at any level in the Mathematics Department, in addition to two prerequisite courses, must take more than the usual number of courses altogether in order to have at least 19 courses outside the department.

Mathematics majors are required to take 8 math courses at the 300- and 400-level or higher, including:

- one course in real analysis from the 320s or 420s, or 300 or 385 or 520;
- one course in complex analysis from the 330s;

- one course in algebra from the 340s or 440s;

- one course in geometry or topology from the 350s or 450s or 360s or 460s, or alternatively, one course in discrete mathematics from the 370s or 470s;

- an additional four courses at the 300-level or higher. Up to three of these may be cognate courses outside the mathematics department, with permission from the Junior or Senior Advisors or the Director of Undergraduate Studies. (Courses from other departments that are cross-listed with MAT do not need permission and do not count toward the total of three allowed cognates.)

The final choice of departmental courses is settled in consultation with the advisors for math majors during the spring term of the senior year.

Students who have particular interests may speak with faculty members about reading courses in those areas not covered in the regular curriculum. Reading courses are intended for students who have taken all the 300/400-level courses in their area of interest and would like to delve deeper into the material. Normally at most one course each term can be a reading course. At most two reading courses can count toward the basic "8 mathematics courses" requirement. Applications for approval of reading courses are available on the Registrar's website, and must be approved by the staff of the Office of the Dean of the College after departmental approvals are obtained.

In addition to undergraduate courses, the Mathematics Department offers some introductory graduate courses that are accessible to undergraduates with sufficient background. These are called "bridge" courses. In general, students interested in taking a graduate course should consult the instructor about the advisability of doing so. Many graduate courses are quite specialized, and are directed towards graduate students and visitors who are working in a particular area. They do not provide a broad enough overview of the field to be of interest to most undergraduates. It is not possible for undergraduates to register for graduate courses online. Please go to `https://registrar.princeton.edu/forms` for the form "Undergraduate Permission to Enroll in Graduate Courses Form". The form must be signed by three people—the instructor of the course, the Mathematics Director of Undergraduate Studies or your Advisor, and your residential college dean—and then sent to the Registrar's office. Once you have received the permission of the instructor of the course, send the form to Michelle Matel, the Undergraduate administrator, at mmatel@princeton.edu.

Applied Mathematics

There are special provisions for students interested in the applications of mathematics to various other areas. Math majors may take up to 3 cognate courses in other departments if the courses have sufficient mathematical content, with the permission

of the advisors for math majors. It is also possible for some of the junior and senior independent work to be in other areas and to be supervised by faculty members outside the Mathematics Department; in these cases there must also be a second reader among the Mathematics faculty, so that the work load and grading can be comparable to that of the other mathematics majors.

Independent Work

Independent work in the junior year is required in each term. It consists of either a junior seminar or a paper written under the supervision of a faculty member. Juniors must participate in at least one seminar. The seminars involve topics outside the regular course offerings of the Department that are particularly suitable for some independent investigation by students. Students work either individually or in small teams on separate projects, presenting lectures to the entire seminar on their work and writing a final paper. Usually the seminars consist of 6–10 students. The Department normally offers two or three seminars each semester, depending on student and faculty interest. Students who would like to have a seminar in an area of special interest are encouraged to talk to faculty members some time before the term begins about possible topics and instructors.

At the beginning of each term, the faculty members offering seminars hold a meeting with all the juniors to discuss the topics and to discuss organizational details. Meeting times are scheduled by consensus of the students and faculty involved.

Students interested in a junior paper in place of a seminar should consult the advisors for math majors and talk to faculty members about possible topics and arrangements. Writing a paper normally involves regularly scheduled meetings with the faculty advisor, at least weekly during the term.

The junior seminars do not count as a course, either for the Mathematics Department or for the University. A junior paper or senior thesis cannot double as the final paper for a reading course. Courses and Independent work, including junior seminars, are separate.

Senior independent work consists of the senior thesis, written under the direction of a faculty member. Several students each year choose to work on topics in applied mathematics, often supervised by faculty members from other departments, with the approval of the advisors for math majors; in such cases, the second reader for the thesis must be from the Mathematics Department. Majors are encouraged to talk to faculty members before the senior year begins about possible topics and about the arrangements and scheduling of the work. A supervisor and tentative topic should be in hand by the third week of senior year at the very latest; students are required to submit to the Undergraduate Administrator a statement from their supervisor, agreeing to supervise the work and sketching the topic. A preliminary report of

progress on the thesis is to be submitted to the Undergraduate Administrator by the end of the fall term, and a formal report is due the second week of the spring term. The advisor and second reader should have finished copies of the thesis to read by the University-mandated due date, which is May 4 in 2020; for the 2019-2020 academic year, a pdf will meet this requirement. In addition to these copies, it is advisable to have a spare copy on hand. A pdf of the thesis must be uploaded to Thesis Central (`https://thesis-central.princeton.edu/`), and a pdf sent to the Undergraduate Administrator. There are no additional format requirements for senior theses in mathematics.

Departmental Grades and Honors

The departmental grade is the average grade of the 8 required departmental courses. If you have taken more than 8 courses meeting the departmental requirements, you may choose your best 8 to count toward the departmental grade, provided that they include four courses that meet the specific subject matter requirements.

Junior independent work each term receives a grade that appears on the transcript, but is not viewed as a course grade. The senior thesis receives two grades, one on the paper itself, based on the originality and the depth of coverage of the topic, and one on the final thesis examination, based on the clarity and completeness of the exposition. That examination is an oral examination, principally an exposition of the thesis before a committee consisting at least of the thesis advisor and the second reader. The examiners may and usually do ask questions about the thesis itself or any relevant background material, particularly the mathematical techniques used in the thesis.

Honors (honors, high honors, and highest honors) and departmental prizes are decided in a meeting of the full Department, based on departmental grades, final thesis grades, and a review of independent work and the general undergraduate program. The departmental prizes are: the George B. Covington Prize in Mathematics, awarded for excellence in mathematics; the Middleton Miller '29 Prize, awarded for the best independent work in mathematics; the Peter A. Greenberg '77 Prize, awarded for outstanding accomplishments in mathematics; the Andrew H. Brown Prize, awarded to the outstanding juniors in mathematics; and the Class of 1861 Prize, awarded to the sophomore with the best record on the Putnam Examination. These awards are presented at the final Departmental Reception, normally held in Fine Hall the afternoon of Class Day. Departmental grades ("the best 8") are not used for any purpose besides these honors and prizes.

Summer Support

Mathematics majors sometimes participate in the summer REU programs (Research Experiences for Undergraduates) available across the country each year. For a list of such programs, see:

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http://www.ams.org/employment/reu.html
http://www.nsf.gov/crssprgm/reu/reu_search.jsp
http://www.maa.org/programs/students/undergraduate-research
        /research-experiences-for-undergraduates
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The Mathematics Department supports a small number of mathematics majors for a summer research program amounting to a total of 8 weeks during the summer. This program is open to students who will be junior or senior mathematics majors during the following academic year. It is an opportunity not just to learn a body of mathematics but also to engage in some independent investigation. A student wishing to participate must find a faculty member who agrees to supervise the program, and in consultation with the advisor must submit an outline of the proposed program. A detailed announcement on how to apply is made in the prior February.

The department has very limited financial support for math majors going to REUs at other schools. Please apply as described above.

From time to time the Mathematics Department has additional summer mathematics programs for undergraduates; these are announced on the Mathematics Department web page.

Study Abroad

A few mathematics majors spend a semester or a year studying mathematics at universities abroad. In the recent past students have studied at Oxford and Cambridge, at branches of the Université de Paris, at ETH in Zürich, at the Math in Moscow Program (in English), at the Budapest Semesters in Mathematics Program (in English), and at various universities in Israel, Spain, South Africa, and elsewhere. Because of the requirements of junior and senior independent work, students who opt for study abroad usually do so in the junior year, and for a single semester. Students interested in any such programs should consult the Study Abroad Program in the Office of International Programs (8-5524, sap@princeton.edu).

Department Life

The Common Room on the third floor of Fine Hall is the informal center of life in the Department. Afternoon tea is available there every weekday afternoon from 3:30 to

4:00. It is a convenient place for informal conversations with faculty, students, and visitors during the day.

Mathematics majors have electronic card access to Fine Hall, and so may use the Common Room and study areas at all times. For questions, see Will Crow on the third floor of Fine Hall.

The Mathematics Library is located at the A-level of Fine Hall. It has a superb collection of books and journals in mathematics, with quite limited check out so that the material should generally be available when needed. It has tables available for study during the hours that the library is open.

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