Concentration in Mathematics

(2015-2016)

What Can You Do With Math?

Concentration in mathematics is an excellent preparation for a career in either pure or applied mathematics, in academia or in industry. Because physics, chemistry, computer science, economics, and even social sciences rely heavily on mathematical methods, a math concentration can provide an invaluable background for many different careers. Concentrators who do not choose to continue in mathematics have often gone on to graduate work in other academic subjects, to actuarial and computer science careers, or to professional training in law, business or medicine. A math concentration is very flexible and has a reasonably small number of requirements, so there are ample opportunities to take electives in related and unrelated fields.

Math concentrators who would like to earn teaching certification to teach in Massachusetts public schools after graduation may want to look into the Undergraduate Teachers Education Program (UTEP). More information about UTEP is available from their web site at http://www.fas.harvard.edu/∼ utep/. The Mathematics Department offers a "Mathematics and Teaching" option for those students concurrently enrolled in UTEP. Students choosing this option need to fulfill slightly different course requirements to receive the B.A. in Mathematics.

Concentration Requirements

Concentration in mathematics requires a minimum of twelve regular, letter-graded, half-courses of which eight must be courses labeled as Mathematics and four may be math courses or ones in related subjects. (Note that a specially certified Freshman Seminar can be substituted for one of the eight Mathematics courses.) Concentrators must attain at least one half-course at the 100-level in each of the three areas: analysis, algebra, and geometry. Students choosing the "Mathematics and Teaching" option haveslightly different course requirements.

In addition to the course requirements, all students are required to satisfy the Math Expository requirement (see the section below). The exact description of the requirements and the list of related courses permitted to count for course requirement are printed in the *Handbook for Students*.

Expository Requirement

Each concentrator is required to submit a 5-page expository paper in Mathematics. The paper should be a coherent, correct and original exposition in a subject of pure

or applied mathematics. The paper should be written during the sophomore or junior year under the supervision of a professor or tutor in a tutorial (Math 99r) or a 100- or a 200-level course that the student is contemporaneously enrolled in. The paper has to be accepted by both that professor or tutor, as well as the Director of Undergraduate Studies. The student should be prepared to discuss the contents of the paper with the professor or the Director of Undergraduate Studies.

Ordinarily students enrolled in a tutorial (Math 99r) automatically satisfy the expository requirement as part of the structure of the tutorial.

The expository requirement has to be met before the last day of the spring reading period of the junior year. Extensions may only be granted by the Director of Undergraduate Studies.

Honors

A candidate for Honors must, in addition to satisfying the above mentioned requirements, submit a senior thesis. The thesis may be on any topic in pure or applied mathematics not directly covered in a student's course work. It need not be an original piece of mathematical research, but should be an original exposition of material culled from several sources. The department strongly urges concentrators to write a senior thesis; this experience tends to provide a much better glimpse of mathematical research and graduate work than taking courses alone. If you think you will write a thesis, be on the lookout for a thesis topic in your junior year. More about senior theses can be found in the pamphlet "Honors in Mathematics", available from the Undergraduate Program Coordinator Cindy Jimenez, room 334. Also, feel free to talk with the Director of Undergraduate Studies, Jacob Lurie, if you need help deciding on either doing a thesis or finding a topic or and advisor.

Transfer Credits

The Department encourages students to take the most advanced courses for which they are qualified. Nevertheless, students who enter as freshmen or advanced standing sophomores will not ordinarily be permitted to count courses taken elsewhere toward the twelve-course requirement. Transfer students wishing to concentrate in mathematics should consult the Head Tutor who will review their transcripts and arrange their concentration requirements.

Changing Concentrations to Math

The Department welcomes students who want to change their concentration to Mathematics as long as it is plausible that they can fulfill the requirements within the time

remaining. Students considering Mathematics may also wish to consider Applied Mathematics, Computer Science, any physical science, or Statistics.

Joint Concentrations

Joint concentrations with other departments are possible to arrange. Common joint concentrations are with Computer Science, Physics, Philosophy and Statistics. Joint concentrations are honors only. If Math is primary, the student must fulfill all of the requirements for Honors in Math (including a senior thesis in Math) plus whatever other requirements are called for by the secondary department. (Consult the secondary department for this information.) If Math is secondary, the Math requirements are as follows: five, letter-graded semester courses in Mathematics with a grade of C− or higher, with at least one course numbered in 110-119, one in 120-129 and one in 130-139. The student must fulfill the honors requirements of the primary field only if Math is secondary. In either case, the final determination of honors is made after consultations between the primary and secondary field.

The AB-AM degree program

The Department offers the AB-AM degree, which allows students who are Mathematics concentrators to obtain a Masters degree (AM) in Mathematics, in addition to their Bachelors degree (AB) during their four years at Harvard. Any undergraduate who wishes to apply for this degree must file an application form for the graduate program in mathematics, just as any other student files for graduate work at Harvard. Only students with Advanced Standing are eligible to apply for this four-year program, and the Department will only accept candidates who have demonstrated sufficient mastery of undergraduate material. If you are considering going on to graduate school in mathematics, bear in mind that the Masters degree will offer you no advantage. The program requires a large number of additional courses in mathematics. In nearly all cases, the Department recommends that students should instead take advantage of the many other academic opportunities that the University offers. Further details of the requirements are available at the GSAS website, http://www.gsas.harvard.edu/, under *Programs of Study*, and from the Graduate Studies Coordinator.

Reading and Tutorials Courses

There are two types of Reading Courses available. Math 60r is designed to give more time for thesis work to senior honors candidates; Math 91r is for students who want to learn a particular topic not covered in a regular course or tutorial. Please read the relevant section of the "Courses in Mathematics" pamphlet to learn more about the requirements and modalities of these courses.

Although tutorials (Math 99r) are not required, students are encouraged to take a tutorial in the course of their studies. Students can take as many tutorials as they want, but only one tutorial may count for the concentration requirements.

Generally one or two tutorials are offered every semester. Typically, tutorials are directed by graduate students, and have four to eight students in them. They tend to be less formal and structured than regular courses, yet require more involvement on the part of the students, who have to make presentations and write papers. Very frequently a topic studied in a tutorial leads naturally to a senior thesis, and the paper submitted for the tutorial will generally satisfy the Math expository requirement.

A description of offered tutorials is placed into concentrators' registration envelopes in September, and another is e-mailed in January. Tutorial descriptions also appear during the first week of each semester on the undergraduate bulletin boards (one opposite room 320, and one opposite room 503 in the Math Department) and are posted at Math Department's website http://www.math.harvard.edu/. Often, tutorials are previewed at Math Table meetings (For more information on Math Tables, see below). A special organizational meeting for tutorials is held the first Wednesday of the fall semester. The spring semester tutorials are organized in the first week of that semester; see the undergraduate bulletin boards for announcements.

Questions regarding tutorials may be addressed to the Director of Undergraduate Studies, Jacob Lurie (lurie@math), or the Undergraduate Program Coordinator, Cindy Jimenez (cindy@math).

Cross-registration at M.I.T.

Students may cross-register to take a course at M.I.T. It is a particularly useful option for students interested in logic and combinatorics. For more information please see the "Courses in Mathematics" pamphlet. You must get *advance* permission from the Director of Undergraduate Studies, Jacob Lurie (lurie@math), to have M.I.T. courses count for concentration credit.

Concentration Advisor

The department assigns all students a faculty member as their concentration advisor. If you prefer to change your assignment, please talk to Cindy Jimenez in room 334 (cindy@math, tel. 495-9116). Your advisor can help you plan your course-work, and will sign your study card. How much contact you have with your advisor and how helpful he or she is will depend almost entirely on your initiative. Feel welcome to drop by during his or her office hours or during our 4 pm teas (see below), or to invite your advisor to lunch at your House (students can invite a faculty member for any meal at their House, courtesy of Harvard – ask the checker in your House's dining hall for the

form). Your advisor can help you plan your courses, choose a thesis topic, a thesis advisor, learn about mathematical research, and apply to grad school.

To insure a minimum of advising, the department has every junior come in for a scheduled 20 minute advising session with two faculty members in the spring semester; post-graduate options and senior theses are often discussed. Juniors will receive a letter by e-mail in the spring. If you do not receive an appointment letter, please contact Cindy Jimenez (cindy@math).

Math Competitions

Each year a large number of Harvard undergraduates compete in the William Lowell Putnam Mathematical Competition. It is open only to regularly enrolled undergraduates in colleges and universities of the United States and Canada. This is a competitive examination given in two three-hour sessions in early December. There are substantial prizes for both individuals and teams, and Harvard students have done extremely well in the recent past. Sign up to participate in the Putnam competition in late September on the bulletin board opposite room 323. Harvard students have also done well in the MAA-SIAM Mathematical Modeling Contest that occurs in early February.

Math Club and Math Table

The Math Department has an undergraduate math club. The club represents the interests and the views of Math concentrators.

The club also sponsors the Math Table, which meets every Tuesday at 5:30 pm at Mather House Dining Rooms A & B over dinner to hear talks by faculty and undergraduates. Anyone, at any level of math literacy, is welcome to come. The talks at the Math Table generally cover topics which fall outside the scope of regular courses. The talks serve three purposes: to introduce undergraduates to various fields of mathematics, to suggest topics for senior thesis research, and to provide a forum for undergraduates to deliver talks on mathematical subjects. The Rogers Prizes are awarded each year for the two best talks delivered by undergraduates. Announcements about the Math Table talks are posted on the undergraduate bulletin boards (near rm. 320, rm. 503) and e-mailed to the concentrators' e-mail list.

If you would like to give a talk at the Math Table, please contact the Math Table coordinator, Professor Noam Elkies (elkies@math).

Communication and E-Mail

To facilitate communication with its undergraduates, the department urges all mathematics concentrators (potential concentrators and those just interested in math) to forward their e-mail address, together with their name and year at Harvard to Cindy

Jimenez (cindy@math). Information about events of concern to math concentrators (for example, job opportunities, math table talks, tutorials, etc.) will be transmitted as it becomes available. Additional information is also available on the Math Department website.

Term-Time and Summer Jobs, Study Abroad

Course Assisting

The Math Department hires undergraduates as CA's (i.e. course assistants). A CA grades homework assignments, leads a section for an hour a week, has office hours, writes solution sets, and attends the lectures of his or her class. For more information on CA positions for the calculus courses (at the level of Math 21 and below), as well as the 100-level courses, go to http://www.math.harvard.edu/jobs/. Most hiring for these positions takes place in the spring.

Science Advising

To help with Science Advising in the fall contact Professor Jacob Lurie (lurie@math.harvard.edu).

Study Abroad

The Office of Career Services can help you arrange to spend a semester or a year studying abroad. Math concentrators have taken advantage in the past of a well-regarded "Budapest Semesters in Mathematics" program in Hungary. The program allows American students to spend one or two semesters studying combinatorics, algebra, and discrete math in small groups with senior Hungarian mathematicians. All classes are taught in English. Applications for the Fall semester are due at the end of April, for Spring in mid October. For more information you can send e-mail to Paul Humke (humke@stolaf.edu) or visit the website http://www.stolaf.edu/depts/math/budapest.

Summer Research

There are opportunities to do pure or applied math during the summer. Browse through the undergraduate bulletin boards (near rm. 320, rm. 503) periodically during the spring semester.

National Science Foundation sponsors a number of Research Experiences for Undergraduates (REU) programs in mathematics every year. You may wind up learning something interesting, *and* making money!

The Weizmann Institute of Science in Rehovot, Israel has an annual summer research program in science and mathematics for undergraduates. They match students with

researchers and provide a modest stipend. The program is conducted in English, and the applications are usually due in late December. More information is available from their website at http://www.weizmann.ac.il/acadsec/kkiss.html.

Large companies, such as IBM or Bell Labs, often hire undergraduates to do research (usually somewhat applied math) during the summer. If you are interested, write directly to the company very early (December is not too early) and look for advertisements posted on the Division of Engineering and Applied Sciences' bulletin boards.

Those who register their e-mail accounts with the department (see "Communications" above) will periodically receive information about some of these opportunities. More announcements will appear on the bulletin boards. You should also regularly check with the Office of Career Services.

Activities and Resources

Concentrators' Party

At the beginning of the fall semester Math Department holds a party for Math concentrators in the Austine & Chilton McDonnell Common Room on the 4th floor of the Science Center. Please come and meet other math majors and faculty members. Refreshments provided.

Access to the Library and the Department

The Birkhoff Mathematics Library on the third floor of Science Center, holds many mathematical books and journals. All texts used in math courses during the semester are held on reserve there. It is a noncirculating library, so its resources may be used only on the premises. The library is open Monday through Friday 9 to 5 pm.

All Math majors may request the card access to the Math Department from the Main Office in room 325.

The Austine & Chilton McDonnell Common Room

The Austine & Chilton McDonnell Common Room, located on the fourth floor of the Science Center, is open to all concentrators and friends of the Mathematics Department. Tea is served Monday through Wednesday (and occasionally on Thursday) at 4 pm. Cheese, bread, and juice is offered at 4:15 or so on Fridays. Harvard Math Department prides itself on its informal atmosphere. Come to these events regularly, and get to know the faculty and graduate students.

For More Information:

Information about tutorials, jobs, graduate schools, fellowships, and other matters is posted on the Undergraduate bulletin board opposite room 320. You can get the pamphlets "Honors in Mathematics", "Beyond Math 1: Which Math Course is for You?", "Mathematical Sciences at Harvard", "Courses in Mathematics", and "Graduate Schools and Fellowships in Mathematics" from the Undergraduate Program Coordinator Cindy Jimenez (cindy@math) in room 334. These pamphlets, as well as some other information is available from the Math Department homepage at http://www.math.harvard.edu/.

For other information consult the Director of Undergraduate Studies, Jacob Lurie, room 514 (5-9493), (lurie@math).