

Graduate Programs and Fellowships in Mathematics

If exploring mathematics is your life's calling, then a graduate Ph. D. program in mathematics is your next step towards that end. This document is meant as a primer for applying to these programs. The topics covered are:

- CHOOSING THE RIGHT PH.D. PROGRAM
- THE ADMISSIONS PROCESS
- FELLOWSHIPS AND FINANCIAL AID
- THE MASTER'S DEGREE

What is said below is also relevant to people thinking about applying to a Ph.D. program in the closely related fields computer science, statistics and applied mathematics.

CHOOSING THE RIGHT PH. D. PROGRAM

What follows are some criteria to consider for choosing the right program. (But note that not all of the criteria will apply to you.)

- **Thesis Advisor**

A Ph. D. thesis (dissertation) advisor plays a central role in a student's graduate education. To elaborate: A Ph.D. dissertation generally consists of making a new advance, thus solving a previously unsolved problem; and your Ph.D. advisor helps you find the problem and serves as an expert consultant along the way. In particular, it takes a mathematician with sound intuition, deep insights and very up-to-date knowledge to help you choose a problem that can be solved (at least in part), but isn't so easy that a you won't gain much by way of knowledge and mathematical sophistication by solving it. And, having an expert consultant along the way is priceless resource.

With the preceding understood: Find out which programs have faculty members doing active research in your field of interest. Do this because no math department has strong research mentors in all branches of mathematics. And, look beyond the well known 'name' graduate programs: Most mathematics graduate programs (even small ones) have some very active mathematicians in specific areas who are excellent thesis advisors. Your academic advisor at Harvard can help you sort out which programs have strong people in which areas.

- **Breadth and Depth**

As important as it is to choose a graduate program with very active research faculty in your field of interest, it is also important to balance this criterion with considerations about the overall breadth of the program. The point being that is common for a person's mathematical interests to change as learning

progresses; and you want to leave yourself the freedom to switch fields and/or advisors without leaving your chosen graduate program.

- **The Strength of Your Peers**

The quality of other graduate students in your program is very important because you will learn much from other graduate students. It is therefore good to have some peers in your program with a math sophistication level equal to (or greater than) your own. On the other hand: The famous programs can be stressful if you tend to doubt your own ability to learn and do mathematics (which is *very* common but no impediment to success if you persevere anyway.) Your academic advisor can help you decide what would be the best balance in your particular case.

- **The Student-to-Faculty Ratio**

An important factor to consider is the student-to-faculty ratio in a program. (Some programs have 10 to 15 grad students working under one advisor.) If you are not confident with regards to your ability to work and learn without much faculty input, then you should look for a program with a small student to faculty ratio.

- **Visiting the Schools**

Before making a final decision on graduate program, visit all your serious choices. The graduate students currently in the program are the best source for information at any given place. Talk to them about accessibility and care from potential advisors in your field of interest. Find out the average number of years to graduation, and (very important) what is the dropout rate. Also, look into the teaching load of teaching assistants since you will likely be a teaching assistant at some point in your graduate program existence. And, ask about the quality of life (for example, check out the housing options). Quality of life outside of mathematics is an important consideration because you will be spending some number of years in your chosen program.

Having talked to the students in the program, then talk to the faculty about their research interests, the number of dissertations they are advising and their general philosophy/strategy for mentoring graduate students. And, ask where their former students are employed.

- **Getting Advice**

You should talk to your academic advisor, the Director of Undergraduate Studies, and other faculty you know well. They can evaluate your choices, give you the latest information about the programs you are considering, and help you decide what is best for you.

- **Applying to Harvard**

The Harvard Math Department encourages its own undergraduates to go elsewhere for graduate study because it is a good idea for a student to get to know other mathematicians and to be exposed to alternative tastes and styles of doing mathematics.

THE ADMISSIONS PROCESS

- **Recommendations**

Admissions committees look very closely at faculty recommendations. To elaborate: Graduate program admissions committees take into account more than just mathematical sophistication/level: They also look kindly on dedicated, motivated and tenacious applicants. Faculty recommendation letters can address these less tangible factors. (In contrast to college admissions, extracurricular activities and non-academic activities are not given much weight.)

Usually two or three letters of recommendations are required.

If you are writing a thesis, you might ask your thesis advisor for a letter of recommendation. Working on your thesis during the fall of your senior year provides an opportunity for your advisor to see your level of mathematical sophistication and your dedication to mathematics.

If you took a course from a professor and did relatively well, you should ask that person to write a letter of recommendation soon after the end of the course. (Memories fade over time, which is why sooner is better than later.) The recommendation can be fine-tuned at a later date to address specific graduate programs or fellowships.

In general, letters from recent course professors carry more weight than letters from courses taken in the first or second year at Harvard. Also, letters from more senior people carry more weight than letters from people just starting out (because the senior people are well known in mathematics circles.)

If you do a summer REU: A letter from an REU mentor can be useful, especially if your work there results in some novel mathematics.

If you work in a mathematically focused summer job in the private sector: Letters from the private sector can also be useful if the job or internship has a significant mathematical component (or statistical or computer science or physics or other scientific component).

If you are thinking of taking some time off after college and applying later, you may still want to get your recommendations written while you are here at Harvard. Remember that faculty members often take sabbaticals, change universities, etc. Ask your recommenders to send copies of your recommendations to your undergraduate house to be included in your personal folder; they may be useful later on. To place a copy of your recommendation in your undergraduate house file you need to obtain a form from your House's Senior Tutor. Harvard will keep these files indefinitely, and will mail the letters you want to graduate schools or employers at your request.

- **Essays**

You will be required to write one or two application essays. An essay should describe your academic background (scientific courses and tangential courses), any research achievements to date, what areas of research fascinate you, and what you hope to do after your degree from the program. These essays also give you an opportunity to explain any bad grades and extenuating circumstances (if any) in your background.

When thinking about the letter: Imagine trying to convince an admissions committee that you are a dedicated, committed and gung-ho (but still novice) scientist/mathematician. (In particular, math programs aren't looking for people who are applying because nothing better came to mind, or because of a missed LSAT or MCAT deadline.)

With regards to your research interests: You certainly don't have to know your dissertation topic in your last undergraduate year. The point is to explain why the program fits your general interests.

With regards to your background: Syrupy letters detailing your love of mathematics since age 4 are not recommended. Make the letter a professional statement of your career goals and interests.

- **Test Scores and Harvard transcript**

Your scores on the Graduate Record Examination (GRE) and your Harvard courses and grades will also be considered by admissions committees. With regards to the GRE: Poor GRE scores (or poor grades) are often used to make the first cut in the admissions selection process. Meanwhile, most math programs do not put too much weight on the differences between good and great scores.

With regards to the courses and grades: Most programs look at transcripts to see evidence of substantial exposure to serious mathematics or related fields (e.g. some graduate level courses or a diverse set of mathematics and related field courses). With regards to grades: Most programs are quite understanding about one or two poor grades earned in the first or second year of college.

- **Taking the GRE**

Most universities require applicants to take two parts of the GRE — the general and the subject tests. The general part is similar to the SAT. The questions on the subject test in Mathematics, although very straight-forward, are for the most part different from the math most students learn at Harvard. Thus, look over some practice tests ahead of time. Even if the questions are straightforward, you have less than a minute per question so if you have to derive everything, you won't finish the test.

The GRE, at least in the usual "paper and pen" format, is offered only 3 times a year: in September, end of October and April. Although you can take both the general and the subject part on the same day, most students prefer not to and many people take at least the general part of the GRE during their third year. In any case, you need to get the GRE out of the way before applications are due (in late December of your final year at Harvard). Best to finish with the GRE before you start serious work on your senior theses and the time consuming process of filling out applications for graduate programs and fellowships.

Also to keep in mind: You have to register to take the GRE more than a month in advance; if you want to take the test at a place somewhere near Cambridge, you should register several months before the test date. For example, if you plan to take the GRE in October, and would prefer to take it in Boston rather than, say, in Albany (remember, you have to be there at 8am) you should register as early as July. GRE information pamphlets are available from OCS, from the GSAS admissions office at Byerly Hall. You can also obtain them from Educational Testing Service web page, <http://www.ets.org/index.html> or from <http://www.gre.org>.

Another note: If you apply for a National Science Foundation (NSF) Graduate Fellowship, then the NSF will actually pay for your GRE test – provided you take it at specific dates. See the NSF application for more information.

- **Deadlines**

The deadlines for graduate school applications range from early December to early January. Most schools usually require you to complete your application folder by January 1st or 15th. The deadlines for fellowship applications start as early as October.

- **More information**

The Office of Career Services has webpages and documents that say more about applying graduate and professional schools and the application process. See the following in particular: <https://ocs.fas.harvard.edu/graduate-school> and <https://ocs.fas.harvard.edu/ma-phd-arts-sciences> and <https://ocs.fas.harvard.edu/file/233111>.

FELLOWSHIPS AND FINANCIAL AID

Contrary to what you might think, **you don't need to pay to go to graduate school in mathematics**. Indeed, graduate students in mathematics are usually paid (albeit not much) to study. There are several ways post-graduate education in mathematics is financed.

- **National Fellowships**

A few students are able to win national fellowships. The national fellowships are awarded by various government and private foundations, and some pay rather large stipends plus 4 tuition for the first three to five years of graduate school. Currently, we are aware of support being offered by the following organizations:

- The National Science Foundation, NSF, is the largest funding agency for graduate work in mathematics, offering both regular Graduate Fellowships and some special ones for minorities. The deadline for submitting the first part of the application is usually in October. NSF will even pay for you to take your GRE's in December! The NSF web page is <https://www.nsf.gov> or go directly to Fastlane, the electronic fellowship application submission web page, <https://www.fastlane.nsf.gov>.
- The Fannie and John Hertz Foundation, a private foundation that purports to support only students in “applied physical sciences”, but, in reality, often funds study for 5 or more years in many areas of pure mathematics. It also has one of the most lucrative stipends. Their web site is at <https://www.hertzfoundation.org/>.

- The Department of Defense. The Department of Defense funds the National Defense Science and Engineering Graduate Fellowships (NDSEG). This is a 3-year fellowship. (It is not like ROTC in that you don't have to promise to serve in the military or have any other special obligations to the government if you win a fellowship.) To get the application and information, check their web site at <https://ndseg.org/>. The application deadline is usually the first week of January.
- Canadian students should look to The Natural Sciences and Engineering Research Council (NSERC), which provides scholarships for graduate study. For information check their web site at <https://www.nserc-crsng.gc.ca/>. (NOTE: the deadlines for these lie early in the fall semester!)

Flyers put out by some of these fellowships are posted on the undergraduate bulletin boards—one is opposite room 320 and another is opposite room 503.

The Office of Career Services (OCS) Web site (<https://ocs.fas.harvard.edu/>) offers useful information for applying to graduate school and for finding sources of funding. The staff at OCS can help you enormously in this regard.

The Harvard Graduate School of Arts and Sciences (GSAS) offers fellowship information online at <https://gsas.harvard.edu/financial-support/fellowships>. See in particular the CARAT Database for Grants and Fellowships: <https://gsas.harvard.edu/student-life/harvard-resources/carat-database-grants-and-fellowships>.

Generally, you should try your luck in the various nationwide fellowship competitions because Harvard students have been very successful in winning these awards.

With regards to deadlines: Some fellowships have early deadlines (as early as September) and some pay more attention to the GRE scores and grades than university admissions offices.

- **University Fellowships**

Any given graduate program may offer fellowships to students who accept an offer of admission. These can be as lucrative as the nation-wide fellowships, and some don't require a separate application – your application for admission might automatically enter you for the competition. Even so, ask the people in the programs you are considering whether you have apply separately for their fellowships.

- **Teaching Assistantships**

Students who do not get fellowships usually receive teaching assistantships. Those generally carry a tuition waiver and a stipend that is sufficient for living expenses in exchange for teaching, grading, or assisting in low-level math courses. (Many departments won't let first-year students teach. These often pay incoming students a stipend, and have them begin teaching in their second year). Some students can get research assistantships which let them stop teaching and concentrate exclusively on research.

- **Study Abroad**

There are fellowships and scholarships for study abroad. Information about these can be obtained on the Office of Career Services (OCS) <https://ocs.fas.harvard.edu/>. Make an appointment to talk to an OCS advisor.

Some of the math/science fellowships are:

- Churchill Scholarship (for study at Cambridge University),
- Herschel Smith Harvard Scholarship (also Cambridge),
- Weizmann Institute of Science Scholarship (the Weizmann Institute in Rehovot, Israel).

In the past, math people from Harvard have also been particularly successful in competing for the Marshall Scholarships (see <https://www.marshallscholarship.org/>), and for Fulbright Grants (see <https://us.fulbrightonline.org/>).

Application deadlines for some fellowships start as early as September. Contact the Office of Career Services for more information about foreign study grants and fellowships.

MASTERS DEGREES

It is rare for students to enter graduate school in mathematics for just a master's degree. However, if this is something you are considering, then talk about this with your academic advisor or the Director of Undergraduate Studies.

The fact is that dedicated master's degree programs in mathematics are not common in the US. What is common practice is to award a masters degree on the route to a Ph.D degree; or to those who drop out from a Ph.D. program after a year or two (you should check the policies of individual programs).

Note also: If you are applying for a master's program only, you may have less (in some universities, significantly less) chance of getting financial aid.

- **Harvard's Concurrent Masters Degree Program**

Harvard primary concentrators in Mathematics degree can apply for the *Concurrent Masters Program*. Students in the Concurrent Masters Program must meet the academic and course requirements for both the BA degree and the AM degree. In this regard, at most four courses can be counted for both degrees simultaneously. (The AM degree requires 8 courses in Mathematics with at least 4 at the graduate level. Moreover, these 8 courses must form a coherent plan of study.) In addition to the course requirements, any candidate for the AM degree in Mathematics at Harvard must take a special language exam to demonstrate the ability to read mathematics in either French, German or Russian.

To apply for the Concurrent Masters Program, you must file an application form for the Concurrent Masters Program in Mathematics through the Harvard Graduate School. An applicant must also submit a detailed plan of study for the program to the Directors of Graduate and Undergraduate

Studies in Mathematics. This plan of study should explain how the proposed 8 courses make for a coherent plan of study and how the program will best facilitate the applicants's long range career goals.

See the document at <https://www.math.harvard.edu/media/AB-AM-Concurrent-2021.pdf> for more information on the Concurrent Masters Program. You can also contact the Mathematics Director of Undergraduate Studies for more information.

FURTHER INFORMATION AND ADVICE

For further information and advice about graduate programs and fellowships in mathematics, please talk to the Director of Undergraduate Studies, Professor Cliff Taubes, your faculty advisor or the House Fellowship Advisor. They can greatly assist you in determining what recommendations and information outlined here applies in your case, and may help you get more information. And watch for advertisements from fellowships and graduate programs on the undergraduate bulletin boards.