GOING TO
GRADUATE SCHOOL
IN THE
MATHEMATICAL SCIENCES

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INTRODUCTION

This brochure has been written for undergraduate students majoring in mathematics or other sciences and engineering. If you are a sophomore or junior in one of these fields and are curious about graduate school, we hope that this brochure will help you decide whether to pursue your studies at the graduate level and will prove useful as you select the program that is most appropriate for you.

The information presented here is based on the experiences of advanced graduate students in mathematics and statistics and covers topics related to the choice of university, field of study and graduate program. It also lists strategies that are helpful when you make your selection and describes some career opportunities in the mathematical sciences.

MAKING THE DECISION

Do you take pleasure in thinking about mathematical or statistical problems? Do you think you would enjoy teaching mathematics or statistics? Does the prospect of engaging in new research on interesting topics in mathematics or statistics excite you? If your answer to most of these questions is "YES," then you are well advised to go to graduate school and develop your intellectual potential.

Graduate school will prepare you for a variety of professional positions that require advanced training in mathematics or statistics. Some of the factors you should take into consideration when making this decision are: the job possibilities after graduate school and the approximate salary levels, your long-term career goals, and the amount of time that you are willing to spend in school. Going to graduate school is not the best option for everyone, however, and it may not be the most appropriate avenue to reach your goals. The best way to find out is to consider your options carefully before making a decision.

Timing is also very important. For some people it is a good idea to work for a few years in order to gain an understanding of applications of mathematics in industry before going to graduate school. For others, especially those interested in academic careers as teaching or research faculty, time spent away from the subject can make it more difficult to return to academics. Talk to people in the field to help you decide what is best for you.

CHOOSING BETWEEN MASTERS AND PH.D. PROGRAMS

Masters degrees usually take about 2 years to complete. They are designed to further the students' knowledge of a particular field beyond the undergraduate level with emphasis on specific areas. Masters programs generally prepare students for jobs in industry and government laboratories, actuarial and also some teaching positions in community colleges but not normally at universities in the United States.

Ph.D. programs take 4-6 years to complete. These are designed to prepare students to conduct research, perform analyses, develop new theories and advance the sciences. To be a university professor in the U.S., it is usually necessary to have a Ph.D. Research positions in industry and national laboratories are also common with this degree.

Students sometimes think that a Masters degree is necessary to proceed to the Ph.D., but this is not true. In fact, many universities' Masters programs are designed to prepare students for the workforce and not for doctoral study. For this reason, keep in mind your final degree objective in graduate school and apply for admission into the appropriate
program. If you enter the Ph.D. program, you can switch to the Masters program if you so desire, but switching from the Masters to the Ph.D. program is often more difficult. If you think you need more time than is allowed by a Ph.D. program to meet preliminary requirements, ask advisors about entering the Masters program with the intention of switching to the Ph.D. program later.

**REQUIREMENTS**

The main requirement for graduate school is a Bachelors degree in your field of interest or a related field. Some mathematics graduate students have degrees in engineering, physics, computer science or other fields. There are many roads that can take you to a Ph.D. in mathematics. Some are direct, with mathematical emphasis all the way, starting from high school. Others are less direct, perhaps taking you through a B.S. degree in a different field first. In the latter case, you may have to start graduate school by taking classes that fill in the gaps in your mathematical background.

Another requirement is the Graduate Record Examination (GRE), both general and subject. The GRE Subject Test is offered every year on the first or second Saturday of February, April, June, October, and December. It is a good idea to take this exam no later than October of the year before you plan to start graduate school. If you are dissatisfied with your scores after the first attempt at the subject test, it is reasonable to repeat it. To allow time to repeat the subject test, take it early. The GRE General Test can be taken at your convenience on a computer at most ETS locations. For more information about the GRE, including the GRE Search Service, write to Graduate Record Examinations, Educational Testing Service, P.O. Box 6000, Princeton, N.J. 08541-6000. WWW address: [http://www.gre.org/](http://www.gre.org/)

Perhaps the most important requirement is letters of recommendation. It is crucial that the people writing a letter on your behalf know you well as a student and are able to give concrete information about you and your potential as a graduate student. It is preferable to request letters from professors in upper division classes in which you have done well, or from faculty with whom you have worked on research projects or a senior thesis. A letter from a professor who hardly knows you will carry less weight regardless of his or her reputation. If you have participated in a summer research program or have been employed in a mathematics-related job, submit a letter from your supervisor in addition to three letters from practicing mathematicians.

Another requirement is to fill out an application for each university. Request all application materials directly from the department where you wish to apply. The package usually includes the application for the program and one for financial aid. These and all supporting material such as transcripts, GRE scores and letters of recommendation have a deadline typically in December or early January for the next fall. Deadlines for private fellowships, scholarships and other external financial aid usually fall in October of the previous school year. The application process takes about one year so it is important to start early. When you submit your application, send all your materials on time. Generally, you will be allowed to apply to only one department per institution.

Some departments may have additional requirements. Read the application carefully to ensure that you fulfill all the application requirements for each of the schools you are considering. Sometimes university student groups sponsor workshops that give advice on what to include if sections of the application have vague instructions or unclear explanations. Some universities offer partially or fully subsidized GRE preparation courses. Check with your local university for these opportunities.
CHOOSING A FIELD OF STUDY

Many undergraduates are strongly influenced by family or friends when choosing a major. Some find out that, in retrospect, their choice may not have been the best one. When choosing a field for graduate school, you should consider your own interests first. One of the most important qualities of a graduate student is dedication. A love for your field of study will make your experience in graduate school rich and will help you succeed. A lack of love for your field can make graduate school very difficult.

If you are changing fields to enter the mathematical sciences, consider taking the time to augment or improve your record in mathematics. In particular, it is advisable to take advanced undergraduate courses in mathematics and to participate in summer research programs and intensive mathematics institutes. Success in these classes and programs will greatly enhance your graduate application. Some information on summer opportunities is listed below. At the time of application, you are not expected to know precisely the topic you want to investigate in your dissertation or what your field of research will be after you finish your doctorate. Usually a general idea is sufficient to get started and you can narrow your interests as you learn new topics in your first years of graduate school. Explore different areas of mathematics that you were not exposed to as an undergraduate. After your first or second year, when you have completed the written and/or oral examination requirements for the Ph.D. and you are ready to begin the research for your dissertation you will have to focus on a particular topic. Your advisor can help you determine if your choice is specific enough or still too broad.

CHOOSING A UNIVERSITY

Some of the issues to consider when making a list of universities you may want to attend are:
- size of the department
- faculty/student ratio
- number of students who complete the program
- whether and where the program’s students enjoy post-graduate employment
- length of the program
- the number of women and other minorities in the department
- reputation of the program and the university.

If you have only a broad idea of your field of interest, you could benefit from a large selection of classes that can help you decide on a more specific topic. Large departments will be able to offer a wider selection of classes. If you have a specific field of study in mind, the size of the department is less important. You should find out at each university you apply, how many professors are actively doing research in that field, how many of them take on new students and if you would like to have any of them as your advisor.

The faculty/student ratio can give you an idea of how much individual attention you can expect and how large your classes may be. Look for a ratio that favors your learning style. The average length of the program will vary from one university to another and so will the percentage of students that complete the program at each university to which you are applying. Though students leave schools for various reasons, some universities take on the students they are reasonably sure will complete the program, while others choose to admit more people than they expect to graduate, the latter resulting in a more competitive learning environment.
In general, the reputation of the particular department where you study is more important than the reputation of the university as a whole. Yet, it is not wise to give excessive importance to reputation; when you look for post-graduate employment, the quality of your work and the letters of recommendation written by your dissertation advisor will be at least as important. The post-graduate positions taken by Ph.D.s from each of your selected universities will give you an indication of your most likely job prospects after completing each program.

It is important to talk to several graduate students and faculty members in the universities you are considering to find out this information. If you can't visit them, call the department office and ask for phone numbers of some graduate students. Most of them will be happy to talk to you. Some schools also have diversity officers who work with the mathematical and physical science departments. Minority and women students are advised to seek out these officers for information and assistance.

The number of minority students and faculty members in the department is a concern for many incoming students. You can find out this information from graduate students in each department, the diversity officer, and the department office. Underrepresentation of minorities and non-minority women should not serve to discourage women and ethnic minorities from attending a particular university but you should be aware of the reality in order to make an informed decision.

STRATEGIES THAT WILL HELP YOU MAKE YOUR SELECTION

* Make a list
Although you may have one or two preferences, make a longer list of universities to which you apply. This will ensure you have a choice among the ones that accept you. If you only apply to one or two schools, you may end up with no choices at all. Include on your list at least one university with very high admissions standards even if you don't feel confident that you can get in; you will never know unless you try. Similarly, include some that have less stringent standards as a safeguard. There is usually a fee involved with each application, and therefore, it can become costly to send too many of them. You can find out from each university about the possibility of getting this fee waived. There may be programs that allow you to apply to several universities with a single fee but these programs are not 100% reliable and not all universities participate in them. Be careful.

* Start Early
It is good practice to start the application process about a year and a half before you start graduate school. Sometimes the material gets lost in the mail or placed in the wrong file. Allow ample time for the universities to receive the material and check with them to make sure none of it is missing. You can call to find out the status of your application and other information by talking to the person in the department in charge of admissions or graduate student affairs.

* Visit Universities
After you receive the letters of acceptance, consider taking a short trip to those universities. Some institutions include interviews and visits to their campuses as a formal or informal part of the admissions process. Even if a visit is not requested, you should arrange for a
visit on your own to talk to students and faculty. Find out if the universities can pay for your visit. From the students, try to find inside information about what it is like to be a student there and what you can expect from the department in terms of personal support.

* **Prepare for Early Requirements**
In some graduate programs, preliminary requirements must be met immediately or within a short period after you enroll. Assess your preparation to meet these requirements. If you think you are underprepared, do not be discouraged. Find out about options that the department offers to new students in your situation.

* **Evaluate Your Choice**
During your first two years of graduate school, while you are adjusting to life in your department, you may decide that it is not the right place for you after all. It is not too late to consider changing departments or, in extreme cases, transferring to a different university. After only one year, you may be able to reactivate your old admissions application at one of the other universities you had considered.

* **Financing Your Studies**
Most universities offer some financial support for graduate students. Sometimes it comes in the form of fellowships, grants, research or teaching assistantships. Some of these will require you to work; others will simply support your study. Each form of support may require a different application and more letters of recommendation. Don't hesitate to ask for these letters and to apply for as many forms of financial support as you can possibly find. It is part of every professor's job to write these letters, and they expect students to ask for them.

The payment of any undergraduate student loans can be deferred while you attend graduate school. Ask about opportunities for financial support in the departments you select, as well as the university financial aid and fellowship offices. Some private companies and consortia, and most government agencies, like the National Science Foundation, have early deadlines for submissions of fellowship applications. Ask a faculty member in your department or at the schools you are considering for more information about government and industry fellowships and deadlines. The person in charge of graduate affairs should be able to give you this information or direct you to someone who is knowledgeable about fellowships.

Ask, too, about fellowships for students chosen from small pools. Two examples are minority students and women students. The financial aid and fellowship offices often have lists of requirements and available stipends offered by the university as well as private and government agencies. Check these lists periodically for any new additions. You can also check with your local church and organizations that serve the particular demographic or religious groups of which you are a member.
CAREER OPPORTUNITIES

Many students with mathematical inclination choose to pursue advanced degrees in engineering, computer science, or even business over mathematics due to a lack of information on career opportunities in mathematics. A typical belief is that mathematicians become university professors, teachers and actuaries. While it is true that some people choose those professions, there are many other personally and financially rewarding careers for mathematicians.

Most of the mathematicians who are not employed in academia take positions in federal government agencies or industry. In the federal government, mathematicians are employed by the National Security Agency, the Departments of Defense and Commerce, NASA, and national laboratories such as Los Alamos and Lawrence Livermore. Employers within service industries include financial advising firms, banks, insurance companies, software development companies, research and development laboratories such as AT&T Bell Labs as well as engineering, surveying and architectural services. Within manufacturing, employers include pharmaceutical companies, aircraft and computing industries such as Hughes, Motorola and IBM. Mathematics, in particular applied mathematics, is frequently done in conjunction with other fields. Fields in which applied mathematics is used extensively include physics, biology, engineering, operations research, economics, chemistry, life and behavioral sciences.

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