Honors in Mathematics
Writing a Senior Thesis
(2015-2016)

Candidacy for Honors

To receive honors in Mathematics, a student *must submit a senior thesis*. This is the only requirement for honors eligibility, beyond basic requirements of the Mathematics concentration. The Mathematics Department recommends students for graduation with honors in Mathematics on the basis of course grades in mathematics, the senior thesis, and a thesis examination. The final award of "latin" honors (*cum laude*, *magna cum laude* or *summa cum laude*) is made by the Faculty of Harvard University in accord with rules set forth in *Handbook for Students*, based on the Department's recommendation and a students grades and subject to overall percentage quotas.

Harvard University also awards degrees *cum laude* "on the basis of a student's overall record": that is, on the basis of grades in all subjects. There is no thesis requirement for this version of the *cum laude* degree. Under present faculty rules, students who qualify automatically receive their degrees *cum laude* if they do not receive honors in a field.

You should consult the *Handbook for Students* for a more detailed description of the general regulations relating to honors.

What is an Honors Thesis in Mathematics?

An honors thesis in Mathematics is an original presentation of an area or subject in pure or applied mathematics. A typical thesis is an original synthesis of knowledge culled from a number of sources in the published literature. A thesis can contain substantive, original mathematics, but most do not.

Why Write a Thesis?

The Mathematics Department strongly recommends that its concentrators write a senior thesis. Writing a thesis provides a glimpse of life as a graduate student in mathematics, and as a professional mathematician. It will also propel you towards the frontiers of current mathematical research. Moreover, working on your thesis can be an opportunity to interact closely with a working mathematician (your thesis advisor), which by itself, offers intellectual rewards.

In the past, almost all the seniors who wrote theses felt that working on one was the most challenging, confidence-raising, and fulfilling experience in their undergraduate careers.

Choice of Thesis Topic

Any subject which makes genuine use of mathematics at the college level is suitable for a senior thesis. The topic may be in pure or applied mathematics, subject to approval from the Director of Undergraduate Studies. In general, a thesis on a rather narrow subject works well, while one presenting the elements of a large theory is less satisfactory

both mathematically and in its value to the student. In judging theses more weight is given to the quality of the presentation than to the sophistication of the topic.

Start thinking about possible topics for a thesis early on. Students planning to write an honors thesis are advised to give serious thought to the choice of topic during their junior year. Your courses, your advisor, as well as Math Table lectures, may serve as sources of questions or subjects that interest you. In the past, tutorials and reading courses have proved especially useful in generating ideas leading to a good senior thesis.

It is important to choose a topic which interests you. Without a real interest it is difficult to do the amount of work necessary to write a good thesis. On the other hand, some students search too long for a topic that they will "fall in love" with, ending up with very little time to actually research and write the thesis. (You should merely like a topic or a field of your thesis. Often you simply know too little about the topic at the outset to realistically decide whether it is what you *really* want to study or not. Just don't pick a topic that bores you.) All things being equal, it is best to write a thesis in an area where you have taken several courses or a tutorial already, and therefore, have some perspective.

Thesis Advisor

If you have not chosen a topic on your own before the end of your junior year you should seek the advice of several faculty members as to areas of mathematics suitable for your senior thesis. Math Table is a good source of informal information too. Spend the summer before your senior year reading up in these fields.

At the end of your junior year or at the very start of your senior year, approach a faculty member whose field of expertise covers your chosen topic and consult him/her regarding your plans. Your academic advisor (the person who signs your study card) is usually not your thesis advisor; but he or she may direct you to a faculty member who would be better suited to be your thesis advisor.

All senior theses are written with the explicit advice of a faculty member. A common pattern is to take a reading course (Math 60r, SAT/UNS) during the fall term of your senior year and continue consulting with the same faculty member informally (or again in the context of Math 60r) during the writing of your thesis in the second semester. Note that your thesis advisor can help the department evaluate your thesis when honors decisions are made.

It may be possible to arrange for a professor from MIT or from another department at Harvard to serve as your thesis advisor. However, in such cases the student must have a second advisor in our department, and must get prior approval from the Director of Undergraduate Studies. In the past a few students who were advised solely by faculty from another department ended up with weak theses and did not receive an honors degree. Therefore, any student whose primary advisor is not a member of the Harvard Math Department is strongly advised to submit to the Director of Undergraduate Studies a complete draft of their thesis 30 days before the final due date for senior theses. This will give the departmental advisor the chance to suggest modifications that can put the thesis into compliance with the department's standards.

As soon as you have decided upon your thesis advisor and the topic, notify the Undergraduate Studies Coordinator, Cindy Jimenez (room 334, e-mail cindy@math).

If you have no topic or no advisor by late September of your senior year, please see the Director of Undergraduate Studies, Jacob Lurie (lurie@math), for help.

Getting Help

Choosing a thesis advisor and a topic can be a nerve-racking experience. Furthermore, while working on your thesis you may encounter difficulties, both logistic and otherwise. (For example, some students have trouble defining their goals or circumscribing the thesis topic; some may even decide to change the topic and/or advisor in mid-semester.) In all these circumstances you are encouraged to talk with the Director of Undergraduate Studies, Jacob Lurie (lurie@math).

Enrolling in Math 60r

Seniors can free up time for thesis research by enrolling in Math 60r. You must get the signature of the Director of Undergraduate Studies and you must enroll SAT/UNS. You can enroll for fall, spring, or both semesters. Students enrolled in Math 60r in the fall need to submit a thesis plan to the Director of Undergraduate Studies before the end of the fall reading period (see below).

Plan of thesis

Each candidate for honors in mathematics would do well to submit a thesis plan, one or two pages long, including at least a preliminary bibliography by 4 pm of the last day of the reading period in December to Cindy (rm 334). If you are enrolled in Math 60r in the fall, the failure to submit such a thesis plan by the deadline will result in an unsatisfactory grade for Math 60r.

The Thesis

Originality

An honors thesis in mathematics is not expected to be (and very rarely is) an original contribution to mathematical research. Only originality of presentation is expected. You should study several presentations of your subject until it is thoroughly assimilated and then write your own presentation of the subject. Theses which are drawn from a single source are not acceptable.

Occasionally, students do make original contributions. These are, of course, welcome; but a student is ill-advised to start work on a senior thesis determined to solve some outstanding classical problem. Progress in research is usually made by acquiring a good grasp of existing knowledge and answering successive small questions. If you do discover something new, be sure to consult with your advisor or some other faculty member about it. He or she may be able to help you go further or protect you from the embarrassment of a serious mistake.

Format

No length or format is prescribed for senior thesis. However, theses exceeding thirty typewritten pages put a considerable strain on the staff and rarely get as much attention as they may deserve. Twenty to twenty-five pages (typewritten) might be considered average; certainly many shorter theses have been judged *summa* quality.

It is not necessary to have your senior thesis typed. A *legible* handwritten thesis is entirely acceptable. However, you may want to typeset your thesis using the math-oriented language LaTeX available on the FAS computer system.

A bibliography *must* be included with your thesis. Please do not forget to put your full name, e-mail address, telephone number, and your thesis advisor's name on the front page of the thesis.

Some old theses are available in Cindy Jimenez's office (rm. 334) for you to look at with regard to style, length and general format.

Deadline

Two copies of the thesis must be handed in to the Undergraduate Studies Coordinator, Cindy Jimenez, in room 334 *no later than 4 pm* on the first Monday after spring recess.

Students Receiving a March Degree or for whom the Fall Semester is their Final Semester

Two copies of the thesis are due by 4 pm on the Monday after Thanksgiving in the office of the Undergraduate Studies Coordinator Cindy Jimenez (rm. 334). Students who wish to plan a timetable for March degree thesis should consult with the Director of Undergraduate Studies, Jacob Lurie (lurie@math).

Hoopes Prize

Your advisor may wish to nominate your thesis to the Hoopes Committee for consideration for the Hoopes Prize, which carries substantial monetary rewards for you and your thesis advisor. If you think that your advisor likes your thesis but may not be aware of the Hoopes Prize, don't hesitate to mention to him or her this possibility. In the past, a large portion of theses submitted for this prize from this department have won it. However, be forewarned that even a super Math thesis will fail to win a Hoopes Prize if its introduction (at least) is not written so that a non-mathematician (but scientifically literate individual) can understand it.

The Thesis Examination

Two weeks after you submit your thesis you may inquire with Cindy Jimenez (rm. 334, Cindy@math) as to which faculty member has been nominated to be your thesis reader. You should then get in touch with your reader to arrange a mutually convenient time for the thesis examination (usually held early in the spring reading period).

Whether the thesis examination will be oral or written will be decided by the thesis reader. If written, the exam will generally be no more than two hours. The aim of the exam is to test whether you have really come to an understanding of your chosen topic. The examination is confined to questions concerning the thesis, direct applications of the thesis, and mathematics related to it. In particular, you are most strongly advised to keep the following very much in mind while writing your thesis and preparing for the thesis exam. No matter how impressively advanced your thesis topic, and no matter how well written your presentation, you will not get a highest honors recommendation if you don't fully understand your subject, or if your understanding is so narrow that you falter on

questions that go somewhat to the side of your chosen path through your subject area.

After your thesis has been read and your thesis examination corrected, you may, if you wish, make an appointment to discuss your thesis and the examination with the reader.

Honors Recommendations

Honors recommendations are voted by the Department at a meeting in mid- or late May. Theses and the results of thesis examinations have great weight in formulating these recommendations, but it cannot be precisely quantified; it isn't a matter of simply computing some sort of weighted average. The departmental recommendation may be no honors, honors, high honors, or highest honors. Sometimes the recommendation is conditional on grades in the courses you have just taken.

All candidates for honors are expected to maintain honors-level grades in their math (and related) courses and to have submitted for their senior thesis a clear presentation of material culled from several sources.

A solid, workmanlike presentation, free of substantive errors, will typically receive a recommendation of honors. Students recommended by the department for high honors are expected to have shown insight into the subject and meaningful originality of presentation in their senior thesis and the thesis examination. They are also expected to maintain a high average in their math (and related) courses. In addition to the above, students recommended for the highest honors are expected to have achieved the kind of mastery of the subject generally exhibited by working mathematicians. (They are not required to have proved original results).

Be forewarned that there is, of necessity, a reasonable degree of subjectivity in the Department's decision-making process. The difference between the highest and high honors recommendations is often intangible. For example, highest honors does not require a thesis with original theorems. It requires neither extra course work in Mathematics above the 12-half-course requirement, nor a record with graduate courses. On the other hand, neither a straight A average nor a thesis with original results will ensure a highest honors recommendation from the Mathematics Department. In any event, only a few highest honors recommendations are made in any given year.

Recommendations from the departments are translated by the Administrative Board into recommendation to the Faculty for degrees without honors, *cum laude*, *magna cum laude*, and *summa cum laude*, using criteria explained in the *Handbook for Students*. These recommendations are acted on by the faculty of Harvard University at a meeting preceding the commencement.

In practice, those recommended by the Department for honors or high honors almost always receive their degrees *cum laude* or *magna cum laude*, respectively, provided their grade-point average is above the relevant cut-offs set forth in the *Handbook for Students*. About two-thirds of those recommended for highest honors graduate *summa cum laude*; the remainder usually receive their degrees *magna cum laude* with highest honors in Mathematics.

Dates to Remember:

- **Sophomore and junior years** – Look for potential thesis topics.

- **End of junior year** – Approach several faculty members for specific suggestions of thesis topics.

- **Summer before senior year** – Read up in the fields of potential thesis topics. Try to make the decision on the topic and become familiar with basic literature on it.

- **September of the senior year** – Choose your thesis advisor. Notify the Undergraduate Studies Coordinator about your choice. Enroll in a reading course supervised by your advisor (optional). (See the Director of Undergraduate Studies, Jacob Lurie, if you have no topic or advisor by the end of September).

- **Last day of the Fall Reading Period** – Submit a thesis plan to the Undergraduate Studies Coordinator Cindy Jimenez by 4 pm.

- **January/February of the senior year** – Start actual writing!

- **March 1$^{\text{st}}$** – Submit a thesis draft to your advisor for feedback and advice. Submit a draft to the Director of Undergraduate Studies also if your primary advisor is not a member of the Mathematics Department.

- **First Monday after spring recess** (or first Monday after Thanksgiving for students planning to receive a March degree or if the fall semester is their final semester) – Two copies of the thesis are due by 4 pm in the office of the Undergraduate Studies Coordinator Cindy Jimenez (rm. 334).

- **3rd Week of April** – Contact Cindy Jimenez (cindy@math) to find out the name of your thesis reader for arranging a thesis examination.