

## HONORS IN MATHEMATICS AND WRITING A SENIOR THESIS

### 1. Candidacy for Honors

A senior thesis is required for high or highest honors in Mathematics, whereas for straight honors (neither high nor highest), a senior thesis can be submitted or four extra courses in Mathematics or approved related fields can be taken (above the required twelve courses). If a Math concentrator submits a senior thesis, then the Mathematics Department recommends that person for graduation with an appropriate level of honors (straight, high or highest or none) based on the student's Mathematics and related field course record, the senior thesis and a thesis examination. If a concentrator does not submit a senior thesis but takes the required four extra courses in Mathematics or approved related fields, then the Mathematics Department recommends that student for graduation with straight honors or no honors in Mathematics on the basis of the grades in all of the student's Mathematics and related field courses. The preceding rules are the only requirement for honors eligibility beyond the basic requirements of the Mathematics concentration.

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 student's grades and subject to overall percentage quotas. (The university allows only a certain percentage of graduates to receive a given level of Latin honors. The Math Department's recommendations and the subsequent awarding of the English honors, highest honors, high honors and honors, is not subject to a percentage quota.)

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, people who qualify automatically receive their degrees cum laude if they do not receive honors in a field. Consult the [Handbook for Students](#) for a more detailed description of the general regulations relating to honors.

### 2. 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 culled from many sources in the published literature. The thesis can contain substantive, original mathematics, but most do not. Even with original mathematical results, a thesis must have a substantial expository component to be well received. Here is one way to think about a thesis: Imagine giving a course on the subject to teach advanced undergraduates or beginning graduate students about the chosen topic. A well received thesis could constitute an elegant set of lecture notes for that course.

Here is what a successful mathematics senior thesis is not: It is not a research paper done during the year or a previous summer or earlier. Even so, an account of completed research can be the sixth chapter in a six chapter thesis with the first five chapters being a detailed exposition of the subject matter and surrounding mathematics.

A thesis is also not a coauthored creation. The writing and composition must be done solely by the candidate for honors. Even so, it is absolutely okay to ask the thesis advisor and/or others to read drafts of the thesis and suggest improvements to both content and exposition. (This is encouraged!) It is also absolutely okay to have a 'chapter six' in the thesis about research done in collaboration if the collaborators are appropriately acknowledged, and if the account of this research is solely that of the honors candidate.

Needless to say: AI should not be used to compose, write or edit the thesis, or any part there-of. (This work is meant to be the candidates creation. And, there is zero reason for writing a senior thesis if recourse to AI is needed. More is said about this below.)

### **3. Why (or why not) write a senior thesis?**

Here are four reasons for writing a senior thesis:

- The reading, writing and thinking about the chosen topic will lead to the frontiers of current mathematical research.
- The thesis process provides a glimpse of life as a mathematics graduate student and as a professional mathematician.
- The process can lead to a close intellectual interaction with a professional mathematician (the thesis advisor).
- Almost all past thesis writers felt that working on the thesis was a most challenging, confidence-raising, and fulfilling experience.

Meanwhile: Here are four reasons for not writing a senior thesis:

- Spend the last year exploring the myriad areas of knowledge that can be learned at Harvard.
- Spend the last year at Harvard working on a research project in mathematics or some other field.
- Spend the last year at Harvard working on a private sector project.
- Spend more time studying or preparing for a professional school.

Something to keep in mind: Whether a person does or doesn't write a senior thesis has little bearing on success or not with job or graduate school or fellowship applications. This is because the latter are due for the most part long before the thesis is due. In fact, it is likely that the only people who notice whether a person does or doesn't get honors will be that person's relatives.

(And, if the relatives are upset about a lack of honors, the Director of Undergraduate Studies will be delighted to set the relatives straight regarding the candidate's mathematical achievements.)

#### **4. The choice of a thesis topic**

Any subject which makes substantive use of mathematics is suitable for a senior thesis whether the topic is in pure or applied mathematics (if in doubt about suitability, check with the Director of Undergraduate Studies). In general, focused theses on a circumscribed topic do well, whereas theses that present the elements of an over-arching theory tend not to. (Moreover, the latter are often less value to the writer.) Here is one more point to keep in mind: The quality of the presentation counts more than the sophistication of the topic. In particular, the thesis topic need not be 'cutting edge' mathematics, it only needs to be cutting edge mathematics to the thesis writer.

To find a thesis topic: First, choose a broad area of mathematics of interest (i.e., analysis, geometry, topology, algebra, number theory, group theory, combinatorics, mathematical physics, logic, probability, ..., or some applied area of mathematics). Having chosen a broad area, then ask some faculty members who research that area for topic suggestions. Faculty will be delighted to give suggestions and to serve as the thesis advisor if one of their topics is chosen. In this regard, don't be shy about asking for more choices if none are super intriguing. And, ask more than one person for suggestions simultaneously because there will be no hurt feelings if no topics are chosen. (This strategy for finding a thesis topic finds a thesis advisor also).

If the preceding strategy fails, ask the Director of Undergraduate Studies in Math or Math faculty advisor to help find a thesis topic and advisor.

With regards to the preliminary step of finding a general area of research: Courses, Math Department seminars and Math Table lectures can serve as sources to wet interest in a general area of mathematics. Tutorials, reading courses and summer research experiences have also proved very useful in this regard.

And about timing: Best to start talking to faculty about senior theses topics in the semester before the start of the last year at Harvard. (This will be the spring of the third year for most people.) If a topic and advisor are arranged before the final year starts, then reading and research for the thesis can start immediately at the very beginning of the final academic year. And, if time is available, some preliminary reading can be done before the start of that academic year. (This said, if compelling alternate activities are set up for the summer before the last year—or for the winter break if finishing in the fall—then by all means make those a priority!)

## 5. The role of the thesis advisor

Almost all senior theses are written with a faculty advisor. The advisor's role is this:

- The advisor can point the thesis writer towards the important literature on the chosen topic and to guide understanding of the literature as the reading and learning progress.
- The advisor can read early drafts of the thesis so as to
  - a) point out areas that need more exposition and/or elaboration,
  - b) point out errors in the presentation,
  - c) point out where the writing could be more elegant.

Take advantage of this opportunity for thesis mentoring by meeting regularly with the advisor (every two weeks is reasonable).

A professor from another department at Harvard or from another university can serve as the thesis advisor (this is not uncommon). However, if a non-Math Department person is the advisor, then a second advisor in the Mathematics Department (a shadow advisor) should be arranged who can suggest changes to the thesis early in the thesis writing stage so that the end result is in compliance with the standards of the Mathematics Department. The Director of Undergraduate Studies can help find a shadow advisor when thesis work starts. To facilitate this, the thesis writer should talk to the Director of Undergraduate Studies about the outside advisor plans very early in thesis process (at the beginning of the fall term for people graduating in May; in the beginning of January for those who are finishing in the fall).

Sadly, there have been, on occasion, students with *only* an outside advisor (or no advisor) whose thesis was not an acceptable mathematics thesis; and these people did not receive an honors degree. To avoid this unpleasant fate: If the primary advisor is not a member of the Harvard Math Department, the thesis writer should submit a complete draft of the thesis to the shadow advisor no later than thirty days before the final due date for the senior thesis. This will give the shadow advisor the chance to suggest modifications that will put the thesis in compliance. (If a draft is submitted to the shadow advisor at the last moment, then the shadow advisor won't have time to read it; and if the advisor does read it, then the writer won't have time to make any substantive changes.)

If a prospective thesis writer lacks a topic or a advisor or shadow advisor by the beginning of the last year (September for May graduates, January for those finishing in the fall), see the Director of Undergraduate Studies for help finding a topic, advisor and/or shadow advisor.

Thesis writers should write to the Undergraduate Studies Coordinator, [Cindy Jimenez](#) (room 334 in the Science Center) giving their chosen topic, their advisor (and shadow advisor if required) when those are set.

## **6. Getting help**

Choosing a thesis advisor and a topic can be a nerve-racking experience. Also, later on, their may be logistic or other difficulties while working on the thesis that the thesis advisor is ill equipped to deal with. In these circumstances do talk with the Director of Undergraduate Studies about these problems and/or concerns.

## **7. Enrolling in Math 60r**

Time can be freed for thesis research by enrolling in Math 60r in one or both semesters of the last year at Harvard. This course is graded SAT/UNS. Students enrolled in Math 60r in their next to last semester (the fall for most people) need to submit a detailed thesis plan to the Director of Undergraduate Studies before the end of the fall reading period to receive a SAT grade. Students enrolled in Math 60r during their final semester at Harvard must submit a senior thesis by the due date (see below for dates) in order to receive a SAT grade. If a person has a change of heart about writing a senior thesis while enrolled in Math 60r, see the Director of Undergraduate Studies to change the course to a Math 91r reading course.

## **8. The thesis plan**

Here is some advice for those writing a senior thesis: Submit a thesis plan in December to [Cindy Jimenez](#) (room 334 in the Science Center), or at the end of May if the fall is the last semester. This plan should be on the order of a page or two and it should contain a preliminary bibliography. If enrolled in Math 60r in the fall, the failure to submit such a thesis plan by the deadline (4pm on the last day of reading period) will result in an unsatisfactory grade for Math 60r. Whether enrolled in Math 60r or not, the process of producing a detailed plan will help focus the mind for the upcoming writing stage of the thesis in the final semester. There is an added benefit: The theses plans are reviewed by the Director of Undergraduate Studies to check on the suitability of the chosen topic and approach.

## **9. Format**

No specific length is prescribed for a senior thesis. This said, theses exceeding fifty typed pages puts a strain on the reader if the writing is less than elegant. On the other hand, thesis below twenty or twenty-five pages are, for the most part, less than meaty and don't fare well as a consequence.

With regards to format: It is not necessary to have the senior thesis typed; a *legible* handwritten thesis is entirely acceptable. However, if a professionally typeset look is desired, LATEX is available on the FAS computer system. (LATEX and its TeX cousins are mathematical word processing programs.)

With regards to what to include: A bibliography *must* be included with the thesis. Also, the front page of the thesis should have the thesis writer's full name, e-mail address and thesis advisor's name..

Theses from previous years can be downloaded from this [website](#); those can give an idea of length and style from these (many are on the long side though). But, keep in mind that theses on that website were not all Highest Honors theses.

## **10. The final deadline**

If the spring term is the last semester: Two hard 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.*

If the fall term is the last semester: Cindy Jimenez must receive two hard copies of the thesis *no later than 4 pm on the first Monday after the Thanksgiving break.*

In no case is a late theses accepted. If the thesis is not finished by the stated deadline above, then hand in what is completed up that point.

## **10. Hoopes Prize**

The thesis advisor may nominate a thesis for a Hoopes prize if it is exceptionally well written. This is a Harvard College wide essay prize open to all Harvard senior theses. (The prize carries substantial monetary reward.) In the past, one or two Mathematics theses per year have received a Hoopes prize. Because this is an essay prize, even the most stratospheric thesis in mathematics will fail to win a Hoopes prize if its first pages (at the very minimum) are not written so that a non-mathematician (but scientifically literate individual) can understand it.

## **11. The Thesis Examination**

Part of the evaluation process for the senior thesis is a thesis examination by the designated thesis reader; the exam is to determine whether the writer understands what was written. To this end, the examination will ask questions about statements in the thesis or about direct applications

of the mathematics in the thesis. In this regard, the thesis writer will not get a strong honors recommendation if what is written isn't fully understood (including simple examples), or if the understanding is so narrow to the extent that questions can't be answered that are slightly to the side of the chosen path taken through the topic of the thesis. This holds true no matter how advanced the topic or how elegant the writing.

With regards to the exam format: The thesis exam can be either oral or written (usually it is an oral exam). The format is up to the thesis reader. In any case, the exam lasts at most two hours (most less than that). For most people, it is reasonably gentle and low keyed.

With regards to the exam timing: A week or two after the thesis submission date, [Cindy Jimenez](#) will email each writer with the name of the thesis reader. The reader will subsequently get in touch to schedule the thesis exam. The exams are typically scheduled before or, at latest, during the last week of classes in the relevant semester.

After the thesis examination, the writer can make an appointment to discuss the thesis and the examination with the thesis reader.

## **12. Honors Recommendations**

Honors recommendations for May graduates are voted on by the faculty of the Mathematics Department at a meeting that takes place either at very end of April or during the first week of May. (For those finishing in the fall, the analogous meeting is near the beginning of January.) The quality of the thesis and the results of the thesis examinations have great weight in formulating the honors recommendations as do the grades in all mathematics and related field courses. This said, the weighting of each component cannot be quantified. This is to say that the decision on honors is not a matter of simply computing a designated weighted average of thesis, thesis exam and math course grades; the process is inherently subjective, and there is really nothing that can be done about that. (Rigorous numerical formulae only hide the subjectivity, they in no way lessen it.)

Part of this inherent subjectivity involves the evaluation of the thesis. This is because different people will (unavoidably) have different points of view with regards to the difference between an honors thesis, a high honors thesis and a highest honors thesis. What follows are some general remarks about these differences.

- A straight honors thesis is a solid, workmanlike presentation that is free of substantive errors and omissions.
- A high honors thesis provides some real insight into the subject matter; and it does so via an elegant, clear and original of presentation.

- A highest honors thesis achieves the mastery of the subject and elegance of exposition on par with a review article by a professional mathematician.

Granted this subjectivity, there are also intangibles with regards to the relative weights given to the thesis, the thesis exam and the grades in mathematics and related field courses. For example, the distinction between a highest and high honors recommendations is often ambiguous: A highest honors recommendation requires neither a thesis with original theorems; nor extra course work, nor a record with mathematics graduate courses. By the same token, neither a thesis with original theorems, nor a straight A average, nor 18 mathematics courses (all at the graduate level), nor all three together guarantee a highest honors recommendation.

Recommendations from the departments are sent to the Faculty of Arts and Sciences for their deliberations. The Faculty of Arts and Sciences takes the recommendation into account when deciding the level of Latin honors at a meeting some days prior to commencement. (The possible Latin honor distinctions are *cum laude*, *magna cum laude*, or *summa cum laude*.) These Latin honors are decided using criteria explained in the [Handbook for Students](#). In practice, people 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 by the Faculty of Arts and Sciences in each year. Some fraction of those recommended for highest honors graduate *summa cum laude*; the remainder receive their degrees magna cum laude or cum laude with highest honors in Mathematics.

### 13. Dates to Remember

- *Second and third years at Harvard*: Explore diverse areas of mathematics so as to ultimately choose a general area for the thesis.
- *Last semester of the third year (the spring semester of the third year for most people)*: Ask several faculty members for specific suggestions of thesis topics, and then choose a topic. If no advisor or topic by the start of first days of the last year at Harvard, ask the Director of Undergraduate Studies to help find a topic and advisor.
- *The beginning of your fourth year at Harvard (the beginning of September for most people)*:
  - a) Notify [Cindy Jimenez](#) about the chosen advisor and topic.
  - b) If the advisor is not a member of the Mathematics Department, find a shadow advisor or ask the Director of Undergraduate to help find one.
  - c) Enroll in Math 60r if desired.
- *Last day of the Reading Period in the second to last semester (December for most people)*: Submit a thesis plan to the [Cindy Jimenez](#) by 4 pm.
- *Just before or at the start of the final semester (January for most people)*: Start writing if writing has yet started!

- *March 1st of the last semester (but November 1 if the fall is the last semester):* Submit a thesis draft to the chosen thesis advisor (and shadow advisor) for feedback and advice. Chapter drafts should be submitted sooner than this date, especially in the case of a shadow advisor.
- *First Monday after spring break (but the first Monday after Thanksgiving break if the fall is the last semester):* Submit two paper copies of the thesis to [Cindy Jimenez](#) by 4pm on that day.