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1 Catalog Description

MATH 0704 Senior Seminar (Fall, Spring)
Each student is required to complete and present a major paper on a topic chosen with the advice of a faculty member. In addition, during the academic year, each student is expected to attend a series of lectures designed to introduce and integrate ideas of mathematics not covered in the previous three years.

2 Course Website

You can find our course website at http://s16.middlebury.edu/MATH0704A.
The site contains a link to a copy of this document. It will also point you to important information about using \LaTeX and \TeX and a template to use for your thesis. You will also see links to pdf versions of several essays on how to present a good talk.

3 Course Supervisor

Michael Olinick
Office: Warner 314, Ext. 5559
E-mail: molinick@middlebury.edu
Office Hours: Monday and Wednesday: 9 — 11 AM, Tuesday and Thursday: 11AM - 1 PM, or by arrangement

4 Purposes of the Seminar

The Senior Seminar in Mathematics has two primary purposes:

• First, to give majors the opportunity to explore in depth a topic in pure or applied mathematics. This experience emphasizes some aspects of education not normally stressed in our regular courses: independent study, library research, organizing and internalizing a chunk of mathematics, expository writing, and verbal presentation of material. The Senior Seminar requires that each enrolled student participate in an active fashion. ATTENDANCE AT ALL THE SCHEDULED SEMINAR TALKS, LECTURES AND FILMS DURING THE STUDENT’S SENIOR YEAR IS DEMANDED: ACTIVE PARTICIPATION IS EXPECTED. We ask all our speakers to gear their talks to
an undergraduate audience so that all student listeners can make sense of what is going on and can learn some mathematics from the presentations.

The major part of the Seminar for each member is the senior thesis. Each student selects a topic under the guidance of a member of the faculty. Students must have a topic chosen and approved by a faculty advisor prior to registration.

- Second, to expose mathematics majors to a number of important and interesting topics in the mathematical sciences that are normally not presented within the department’s set of required courses. This goal is accomplished by the series of talks given by visiting mathematicians, members of the Middlebury faculty, and the senior majors.

5 Schedule

The following schedule of deadlines will be in effect for Spring Semester, 2016:

Week 1: Inform me of your thesis topic and faculty adviser, and find at least one core reference. Register for the course, if you have not already done so. E-mail details to MATH 704 adviser (molinick@middlebury.edu) by 5 PM on Friday, February 17. Install the appropriate version of LaTeX on your computer.

Week 2: Give a 5-minute presentation in class on your thesis topic. (Thursday, February 25)

Week 3: Submit to thesis adviser and MATH 704 supervisor a bibliography of books, papers, and other references. (Thursday, March 3)

Week 4: Give another 5-minute presentation on your thesis topic (Thursday, March 10) and submit an outline of your thesis to both advisers.

Week 6: Give a 10-minute presentation on your thesis topic using Beamer (and Thursday, March 24).

Week 8: Submit first draft of thesis to thesis adviser (Thursday, April 14)

Week 10: Submit second draft of thesis to thesis adviser (Thursday, April 28)

Week 11: Get excited!

Week 12: Submit final draft of thesis to thesis adviser (Monday, May 9)

Week 12: Presentation of thesis talks (Tuesday, May 10 and Thursday, May 12)

Week 13: Submit polished final thesis to MATH 704 supervisor by 5 PM on Monday, May 16. You should hand in three printed copies and one digital version (disk or CD). Late Penalties: The department’s policy normally
requires a minimum penalty of a drop of one grade for each day, or portion thereof, the thesis is late. Thus a thesis which would have been awarded an A based on quality, for example, would receive an A- if the final version is submitted between 5 PM Monday and 5 PM Tuesday, a B+ if submitted between 5 PM Tuesday and 5 PM Wednesday, a B if submitted between 5 PM Wednesday and 5 PM Thursday.

In addition to weekly class meetings, it is the student’s responsibility to meet with the faculty adviser at least once a week.

You should begin with the realization that the senior seminar in mathematics is supposed to be the capstone of your educational experience at Middlebury. It should be your number one priority for the term. In the second half of the semester, large blocks of your time will be devoted to writing your paper.

This schedule requires the student to make an early commitment to a particular topic and to begin work on that subject at the start of the term. You can eliminate some of the last minute all-nighters and panicky final days by disciplined work in the first half of the term. Set a definite period of time each day which you will devote to your thesis. Arrange regular meetings with your adviser at least once a week.

The bibliography, thesis outline, and the first and second drafts will normally be evaluated and returned to the student by the thesis supervisor within one week. The thesis supervisor will read the final draft and indicate corrections which must be made before the polished final thesis is submitted. The evaluation of how well these course requirements were met will be considered by the Department Faculty in determining the final grade for the course.

Students sometimes experience difficulty in their first independent learning experience. The structure imposed on you in regular courses – classes meeting two or three times a week, daily homework, scheduled examinations – makes it somewhat easier for you to organize your time and to discipline yourself to meet deadlines. Some of that structure is (deliberately) missing from the Senior Seminar. You will have to take more initiative in organizing your schedule to complete the work on your thesis.

6 Academic Integrity and Plagiarism

The habit of intellectual honesty is essential to both intellectual and moral growth. Effective evaluation of student work and helpful instruction can take place only in an environment where intellectual honesty is respected.

The relevant Middlebury College Handbook language is as follows:
“As an academic community devoted to the life of the mind, Middlebury College requires of every student complete intellectual honesty in the preparation of all assigned academic work.”

“Plagiarism is a violation of intellectual honesty. Plagiarism is passing off another person’s work as one’s own. It is taking and presenting as one’s own the ideas, research, writings, creations, or inventions of another. It makes no difference whether the source is a student or a professional in some field. For example, in written work, whenever as much as a sentence or key phrase is taken from the work of another without specific citation of the source, the issue of plagiarism arises.

“Paraphrasing is the close restatement of another’s idea using approximately the language of the original. Paraphrasing without acknowledgment of authorship is also plagiarism and is as serious a violation as an unacknowledged quotation...

“The individual student is responsible for ensuring that his or her work does not involve plagiarism. Ignorance of the nature of plagiarism or of College rules may not be offered as a mitigating circumstance.” [Middlebury College Handbook 2002-2003, page 105]

As many theses in our department involve restatements of known theorems and the proofs of the same, the question of plagiarism may be relevant to you. Your thesis adviser will be able to answer any questions you may have about this subject. It is your responsibility to consult with him/her.

It is your responsibility to uphold the Honor Code and adhere to its guidelines on plagiarism for your senior thesis. Sources (books, articles, personal communication) used in the process of your work (including both discussion and proofs of theorems) must be cited, though basic definitions and statements of textbook results need not be. It is not acceptable to reproduce discussion or proof of a mathematical theorem or concept line-for-line, nor is it acceptable to paraphrase. Discussion and proofs in your thesis should be written from your own understanding of the material. All proofs should be worked through for yourself; guidance from reference sources and/or discussion with others is acceptable, but it must be credited appropriately. Please take this seriously. Over the past few years charges of academic dishonesty have been brought against a number of Mathematics thesis students!

7 Texts

There are no required texts for the seminar, but we recommend On Writing Well, 6th Ed., by William Zinsser as a good general guide to expository writing and the always indispensable The Elements of Style by William Strunk and E. B. White.
There are also several excellent short books on the writing of mathematics. These include:

- *How To Write Mathematics* by Norman Steenrod, Paul Halmos, Menahem Schiffer, and Jean Dieudonne,
- *A Primer of Mathematical Writing* by Steven G. Krantz,
- *Mathematical Writing*, edited by Donald E. Knuth, Tracy Larrabee, and Paul M. Roberts, and
- *Handbook of Writing for the Mathematical Sciences* by Nicholas J. Higham.

*The Grammar According to West* by Douglas B. West can be found here, http://www.math.illinois.edu/~dwest/grammar.html.

A copy of these books will be available on reserve in the main Library. Some reading assignments from these books may be made.

8 Library Assistance

The College’s reference librarians can be of enormous assistance to you in assisting you to identify and locate relevant materials whether in printed or digital format. Contact Bryan Carson (extension 5341), who is the science librarian most familiar with mathematics materials.

You may also apply at the Circulation Desk at the Library for special senior thesis privileges, such as extended checkout periods, a carrell, or a locker.

9 Thesis Expectations

Theses that earn good grades have some of the following qualities in common:

1. *Well presented.* The thesis should have a minimum of typographical errors and misspelled words and be neat and evenly spaced. Take the time to run a spell checker and to proofread. Spelling and grammar do count. Have a friend proofread it for you; new eyes will see mistakes you’ve missed. Even if the content is great, you won’t get a top grade unless it is also presented in a readable, comprehensible manner.

2. *Relatively difficult mathematics.* You must learn something new, something you did not see in a class, and something with substance. The work does not have to be very broad, but it should be somewhat deep. One option is to take a narrow topic and learn a lot about it. You should understand the topic and be able to explain it in your own words.
3. **Independent work.** You should do most of the learning on your own. Read the material; try to work through proofs by yourself. Feel free to ask questions of your adviser, but do not expect your adviser to present the material to you or to do the proofs for you. If you get stuck, it is perfectly acceptable to ask for hints or for you and your adviser to work through a problem together. Ideally you should combine material from several sources and draw your own conclusions or arrange the material in an original way.

For example, you might pose a problem. Then you could try to work out your own solution (or examples) and/or find several different solutions (or examples) from several different sources. You might discuss the similarities and differences of these solutions: Do they use different types of mathematics? Do you use both number theory and geometry? Can you draw your own illustrations or examples of these methods? Insert some of yourself into your thesis – your opinions, your arrangement of material, your own proofs, or your examples.

4. **Correctness (or accountability).** Check your definitions; be sure that your theorems are correct and that your proofs make sense to you. Can you explain them in your own words? Be very careful that you’re not just mimicking someone else’s proof and that you really do understand the words you are using.

There is a fine line here between doing your own work and plagiarizing someone else’s. If you copy something word for word without using quotation marks (or setting it off in a narrow paragraph) and including a citation, that is plagiarism. Using well established definitions from the literature is not plagiarism, but you must acknowledge your source. It is not acceptable to string together paragraph after paragraph of quoted material. You should be doing most of the writing yourself, using quotations to support a point.

As you are writing your drafts, note carefully what sources you are using for ideas and arguments. It is always better to err on the side of over-citation! You should include citations and references in your drafts of chapters as you go along. This practice has two advantages: it is quicker and easier to do it this way, and it ensures that your thesis advisor can provide you with advice about the adequacy of your citations and your use of source materials.

For the expository parts of your thesis, gather the information and then express the ideas in your own words. The definitions can be quoted. The proofs should be, as much as possible, your own. That doesn’t mean that you have to prove everything yourself. Working through someone else’s proof is a perfectly acceptable thing to do. However, when it comes time to write up your thesis, you should try, as much as possible, to express the ideas in your own words.
5. *Parts completed on schedule.* This means not only meeting all intermediate deadlines, but also holding regular (usually weekly) meetings with your adviser. This is not meant to be a last minute, night before project. This is meant to be a semester long research project. Get each part done on time! Get regular feedback from your adviser. You will need the time available to absorb and understand the difficult concepts. If you understand all of the ideas the first time through, then your problem (project, topic) may not be hard enough.

6. *Appropriate depth and length* Your thesis should delve deeply enough into the subject area that your analysis requires reasonably sophisticated undergraduate mathematics. Your treatment of the material should be sufficiently extensive to explore the topic thoroughly and carefully, but do not overdo the length. Most theses are between 40 and 60 pages in length. Theses that run longer than 60 pages tend to be hurriedly and awkwardly written. You will need to get permission for your thesis advisor to go beyond 60 pages. The department has set an absolute maximum length of 100 pages for a senior thesis. Your goal should be *Quality*, not *Quantity*.

10 **Basis for Evaluation**

In many departments of the College, a senior thesis is an option available for students seeking Honors in the majors. In our program, all majors are required to complete a one term senior thesis. The distribution of grades in MATH 704 has followed a pattern quite similar to the distribution of grades in other senior level courses in the department. For your information, here is a distribution of MATH 704 grades from 1975 through Fall 2011 (note that A+ is no longer an available grade):

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number</th>
<th>Grade</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>12</td>
<td>C+</td>
<td>34</td>
</tr>
<tr>
<td>A</td>
<td>94</td>
<td>C</td>
<td>16</td>
</tr>
<tr>
<td>A-</td>
<td>126</td>
<td>C-</td>
<td>9</td>
</tr>
<tr>
<td>B+</td>
<td>129</td>
<td>D</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>89</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>B-</td>
<td>54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Keep in mind that each year the department awards the Dr. Francis D. Parker, ’39 Mathematics Prize. The award was established in 1993 by Dr. Francis D. Parker, class of 1939. It is awarded to the graduating student for the best senior work in the mathematics department and is largely based upon the senior thesis, though other accomplishments (Putnam scores, Green Chicken scores, conference participation, etc.) are considered as well.
11 Typsetting Your Thesis: \TeX{} and \LaTeX{}

After a highly successful experiment in Fall 2005, the Mathematics Department decided to require that all seniors compose their theses using \TeX{}. \TeX{} is a typesetting system created initially in the late 1970s by Stanford mathematician and computer scientist Donald Knuth. Knuth designed \TeX{} to allow any individual to produce high-quality typeset books and articles using a reasonable amount of effort, and to provide a system that would give the exact same results on all computers, now and in the future.

\TeX{} is generally considered to be the best way to typeset complex mathematical formulas, but, especially in the form of \LaTeX{} and other template packages, is now also being used for many other typesetting tasks. \LaTeX{} offers programmable desktop publishing features and extensive facilities for automating most aspects of typesetting and desktop publishing, including numbering and cross-referencing, tables and figures, page layout, bibliographies, and much more. \LaTeX{} was originally written in 1984 by Leslie Lamport and has become the dominant method for using \TeX{}. Few people write in plain \TeX{} anymore.

Software packages that incorporate \LaTeX{} and \TeX{} are widely available on the web and are free of charge. We recommend MikTeX for Windows users and TeXShop for Macintosh users. Mac users should follow instructions for obtaining TeXShop at http://pages.uoregon.edu/koch/texshop/obtaining.html. When you launch TeXShop, you will find some demos for getting started under the Help menu. Windows users should head for http://www.miktex.org/

Several books on using \LaTeX{} have been put on one-day reserve at the library. They are:

- *Learning \LaTeX* by David Griffiths and Desmond Higham. I highly recommend you purchase a copy.
- *A Guide to \LaTeX: Document Preparation for Beginners and Advanced Users* by Helmut Kopka and Patrick Daly.
- *The \LaTeX{} Companion* by Michel Gossens, Frank Mittelbach, and Alexander Samarin.
- *First steps in \LaTeX* by George Grätzer.

The introduction to \LaTeX{} by Griffiths and Higham is a particularly friendly guide. It is short, engagingly written with many examples showing side-by-side the \LaTeX{} code and the final typeset text. We will distribute excerpts from this book for your use. A preliminary edition is available in pdf format at http://www.maths.dundee.ac.uk/~ftp/na – reports/CS01LaTeXGuide.pdf and also in the Handouts folder of on the classes server.
In the Handouts folder there is a more complete guide to \LaTeX, titled *A Not So Short Guide to \LaTeX* by Tobias Oetiker et al.

Professor Swenton has prepared several templates for use with \LaTeX that will make it easy for you to begin composing your thesis. These are contained in the folder mcthesis which is the Handout folder.

For your final presentations, we recommend the use of Beamer which is far superior to PowerPoint. A good place to start learning about Beamer is http://homepages.math.uic.edu/~hurder/math589/beamer/. We’ll do a workshop on Beamer later in the term.

### 12 How To Give a Good Talk

A number of distinguished mathematicians and expositors have written useful guides to giving effective presentations of mathematics. We recommend them for your reading. You can find pdf versions of these essays in Handouts section of the MATH 704 folder on the CLASSES server:

- Paul Halmos’ ”How to Talk Mathematics”
- Terry Tao’s ”Talks are not the same as papers”
- Jordan Ellenberg’s ”Tips on giving talks”
- Bryna Kra’s ”Giving a talk”
- William Ross’ ”How to give a good 20-minute math talk”
- John McCarthy’s ”How to Give a Good Colloquium”
- Joe Gallian has written a short but perceptive article, ”How To Give a Good Talk,” giving very practical suggestions for giving mathematical talks. His article follows.
How to Give a Good Talk

by Joseph A. Gallian

Math Horizons, April 1998

This article appears here with the permission of the Mathematical Association of America.
How to Give a Good Talk

Presentations by undergraduates at professional meetings has increased dramatically in recent years. And more and more undergraduates make presentations in classes, seminars and colloquiaums. Learning how to give a good presentation is a valuable skill that many students will find useful in connection with their employment. Baseball manager Joe Torre once said that the teams that are most successful are the ones that do the little things well. Doing the little things well is the secret to giving good talks as well. Here is my advice on how to do the little things well when giving a talk.

Preparation

☐ Inquire about the target audience.
☐ Determine the level of knowledge of the target audience.
☐ Choose a subject that will appeal to the intended audience.
☐ Don’t overestimate what the audience knows about your subject.
☐ Don’t try to do too much.
☐ Use simple examples and concrete special cases. A “nonexample” often helps to clarify a concept. (For instance, if you use the integers modulo 7 as an example of a finite field, be sure to point out that the integers modulo 6 is not a field and why.) Use intuitive definitions rather than technically correct ones. Avoid details. Mention applications.
☐ Choose a short and informative title.

(Cute titles are usually poor titles.) “On a Theorem of Hilbert” is too vague. “On Hilbert’s Basis Theorem” is short and informative. In your abstract, indicate the level of the talk. (Examples: “This talk is intended for a general audience”, “This talk is suitable for those who have had linear algebra”; “This talk is suitable for those who have had real analysis.”)

☐ Keep technical terms and unfamiliar symbols to a minimum. When you do use them remind your audience of their meaning from time to time.
☐ When possible, relate your topic to other fields.
☐ Provide a context for your talk. Explain how you got interested in the subject. Mention others who have worked on the subject of your talk.
☐ Use transparencies. A chalkboard talk comes across as slow moving. Make the transparencies up well in advance and number them.
☐ Use multicolors in preparing your transparencies. Blue, green, red and purple show up best. Avoid orange and brown. Use permanent ink (water soluble smudges easily). You can fix mistakes with rubbing alcohol.
☐ Write very large or use a large font (even for a talk in a small room). If you reproduce printed material, enlarge them for the transparencies. Use color photocopy machines to make color transparencies.
☐ Prepare a crisp beginning. Perhaps start with a question, an application or a prop.
☐ Don’t put much on the transparencies. Use key words and phrases instead of entire sentences. Avoid filling transparencies with equations and formulas. (Don’t compute in public.)
☐ Use pictures, tables, lists, models and props.
☐ If you need a particular transparency more than once in your talk, make multiple copies and insert them at the appropriate places rather than trying to use a single one more than once.
☐ Use overlays when appropriate. Tape them in place so that you can simply flip them over.
☐ Replace the thin tissue paper separators that come with transparencies with heavier paper.
☐ Rehearse your talk but do not memorize it.
☐ Practice with an overhead projector and time your talk.
☐ Divide the latter portion of your talk into modules that you can unobtrusively disregard if time becomes a problem. If you have to omit portions of your talk, don’t tell your audience that you are doing so. (You will come across as not well prepared.)
☐ Anticipate questions you may be asked and prepare a response to them.
☐ Conjectures and open problems add interest.
☐ Use brief reminders to yourself (a word or two) on your transparencies to be sure you do not forget to mention certain items.
☐ Have references or handouts prepared.
☐ Prepare an off campus talk by first giving it in your department or a class.
☐ Plan to dress nicely. It gives the impression that this talk is an important event for you and that you want to look your best.
Delivery

☐ Show up early to check out the room and the equipment. Request a large table on which you can place your transparencies. If possible, have the projector at chest level and the screen high over your head. Experiment with placement of the projector and the focus to obtain the best results. If more than one projector is available, use the brightest one. Keep the room lights on. If possible, remove barriers (such as a lectern, tables or chairs that won’t be used) between you and the audience. Keep electrical cords away from where you may walk. Trying to use two projectors is often awkward and distracting. I recommend against it.

☐ Bring your own marking pens and blank transparencies. (It is surprising how often the pens provided by the host are dry.)

☐ Erase chalkboards even if you don’t plan to use them.

☐ Let your audience know that you are happy for the opportunity to speak to them.

☐ Don’t distribute handouts at the beginning or during your talk. People will read them rather than listen to you. Mention at the outset the handouts will be available after the talk so that the listeners won’t bother to take notes.

☐ Don’t read your transparencies. A glance should be all you need to see to speak about their content.

☐ Be sure not to block the image. Glance at the screen often to check that the transparency is placed properly.

☐ Don’t stand in one place. Move, move, move! Occasionally move toward the screen. Move off to the side often. Step closer to the audience on occasion. A talk seems slow moving when the speaker is stationary. If you have a transparency that will remain up for few minutes, you can walk in front of the table or from one side of the screen to the other.

☐ Use a cover sheet so that you can reveal transparencies a portion at a time. Write each portion in a different color so that you can easily determine how much to reveal each time. Leave transparencies in place as long as possible.

☐ Repeatedly remind the audience of unfamiliar definitions.

☐ Personalize your presentation. Sprinkle anecdotes, humor, quotes, and personal items throughout your talk. Make clear what your contributions to the subject are. You can mention your failures as well as successes.

☐ Smile. Give the impression that you are enjoying talking about this subject and that you are excited to have an audience.

☐ Show enthusiasm for the subject. If you don’t, your audience won’t be enthusiastic either. Put a lot of energy in your talk. Your energy will energize the audience. (Why do people enjoy rock concerts even though the music is greatly inferior to the recordings? Answer: The energy of the live performance.)

☐ Make eye contact. Single out a particular person in the audience who appears to be interested in what you are saying. Look directly at him or her. Then move on to another person, and another. Their interest will energize you.

☐ Speak loudly. Project to people in the back. Vary your voice for dramatic effect. Occasionally change pace. Careful use of pauses will greatly enhance your effectiveness. For example, a good time to pause is when stating a major result, raising a question or showing a complicated figure.

☐ Ask questions or rhetorical questions. Give the audience time to contemplate your questions.

☐ It is not necessary to prove anything. If you can provide an insight about a proof with a few words or picture, do so.

☐ Don’t belittle your own results or downplay your knowledge of the topic. It reduces your credibility to no benefit.

☐ Don’t exceed your allotted time. (To do so indicates you were poorly prepared and have bad manners!)

☐ Avoid annoying mannerisms in speaking. Don’t overuse “OK”; don’t interrupt yourself with “I mean” or “you know.”

☐ Have a grand finale. It could be the main result, a conjecture, an open problem or an application. Thank your audience. Don’t ask for questions. The moderator should do that.

☐ When you are asked a question, move towards the audience. If you are in a large room and someone asks a question, repeat the question.

☐ Plan to stay after your talk. People may want to talk with you about it.

☐ After your talk do a self evaluation. Make notes about what went well and what could be done better next time.