

## Mathematical Sciences IS Student/Advisor Guidelines

To meet the graduation requirements of The College of Wooster, the major in mathematics requires a two-course Independent Study Project, which culminates in an Independent Study Thesis along with an oral presentation describing the Thesis. The additional college requirement of one course in Independent Study is satisfied by work in courses above 212 taken to fulfill the major. This Guide is intended to complement the general regulations governing Independent Study as articulated in the College's Handbook for Independent Study and to assist students in the planning, organization, and completion of the Independent Study Thesis. This guide also provides a description of what the IS advisor expects from the student.

Independent Study is of central importance in the mathematics major and in the entire academic experience of the student. Independent Study is the student's opportunity to do a significant piece of work in an area of personal interest and to expand his or her understanding of mathematics. The ability to engage in independent study is one of the primary goals of the major, and the successful completion of the I.S. Thesis represents the culmination of the student's academic program. To this end we recommend that the student give serious thought to the Independent Study requirement and become thoroughly familiar with the *Handbook for Independent Study* and this *Guide*. We reserve the right to make changes in future editions of this Guide.

### Project Topics:

The range of topics in mathematics is very broad. Theoretical, applied, pedagogical (for those intending to be certified to teach), and perhaps historical independent study topics are possible. The crucial question the student must ask when evaluating a possible topic is: "**Will there be a significant increase in my knowledge of some area of mathematics or in mathematics education?**" The previously mentioned conversations with faculty members will be helpful in answering this question. Since Independent Study constitutes two courses in the major, it is expected that about two courses worth of work in mathematics beyond that in previous courses will be done.

The topic should be chosen on the basis of the student's total academic experience and personal interests. Students are encouraged to develop projects that grow out of previous course work and related reading. Often topics, which can be only surveyed briefly in a formal course, can be expanded into an appropriate I.S. Thesis. Some practical considerations that should be taken into account when choosing a topic:

1. **Personal background and ability.**

Be sure that the topic chosen is within the range of your abilities as determined by your previous course work and reading. For instance, a student would be unwise to choose a topic in the area of topology or probability if no formal courses have been taken in these areas. This holds true especially in application-oriented topics from specific subject matter areas. For example, a student should not choose a math modeling project in biology without demonstrable background in biology as well as the formal course in mathematical modeling.

2. **Manageability and available resources.**

Be sure that the project is narrow enough in scope to complete within the time allotted for the I.S. Thesis. A student should be certain that there exists a sufficient bibliography to support the project. Necessary materials that are not among the holdings of the Andrews Library can usually be acquired through other Library services, although a considerable time lag might be involved. Therefore, students should use existing resources available on campus as much as possible.

3. **Limitations.**

1. The project must expand the student's knowledge and demonstrate a synthesis of information on a topic from many sources.

2. There must be resources available, or which can be readily acquired, for the project.
3. The student must have the appropriate mathematical background for the project.
4. A faculty member must agree to supervise the project.
5. Working selected problems from a single textbook on any topic will not constitute an acceptable I.S. project.
6. The history of an area of mathematics is not acceptable in and of itself unless it encompasses the learning of a significant body of mathematics.
7. Although the faculty advisor must approve all topics, the student is free to pursue virtually any area of mathematics that is of interest. Some suggested topics include Abstract Algebra, Number Theory, Partition Theory, Combinatorics, Graph Theory, Matrix Theory, Operations Research (Deterministic and Stochastic), Mathematical Programming (Linear, Nonlinear, Integer, Dynamic), Management Science, Topology, and Algebraic Topology.

## **Project Submissions**

### **Project Proposal:**

The project abstract is a formal document, not a slip of paper with a few vague ideas on it about what the student thinks would be interesting to do. In order to receive approval for a project, the student will present a proposal outlining the following:

1. The project's focus (e.g., examine the Riemann Hypothesis, study Queuing Theory, examine the Axiom of Choice).
2. The project's objectives in terms of the topics that the IS thesis will cover and the learning that will result from accomplishing the project;
3. The efforts that will contribute to the project: programming, interviews, special library research, trips, and needed materials (books, software, documentation, etc.).
4. Potential problems in the project that might become trouble spots. Identify the challenges the student might encounter in accomplishing the project. The student should investigate whether these trouble spots could make the rest of the project impossible if they can't be surmounted.
5. A suggested timetable specifying the points throughout the two semesters at which the various phases of the project will be complete.
6. A minimum of five references (journal articles, technical reports, books) on your proposed topic. Online references are not, generally, acceptable.

## **Project Research**

The project should begin with a substantial amount of library research. The description of this research should involve a clear exposition of the problem or research area, an annotated bibliography, and an outline for conducting the research.

### **Annotated Bibliography**

An annotated bibliography is a bibliography in which each entry includes a description of the entry's content and the role it might take in the research. This description is not a copy of the entry's abstract. For example:

Taalman, Laura. "Taking Sudoku Seriously." *Math Horizons*. September 2007, 5-7. The author gives an overview to the Sudoku puzzle, including the rules and counting the number of possible Sudoku boards. It is an introductory article complete with concise terminology to use, mention of results about Sudoku and remaining open questions are included. Many of the primary resources in the article should be investigated and evaluated.

### **Thesis Outline**

This will include a proposed table of contents (outline) for the thesis. The table of contents should include a title and a specification of chapters and sub-sections.

### **Completed Chapters**

In mid-October, the student will reach an agreement with his/her advisor about a comprehensive narrative to be completed as a prerequisite to satisfactory completion of the first semester of Senior IS. This comprehensive narrative must be submitted by the date given on the timeline later in this document. The comprehensive narrative is not an outline or a draft, but a significant written portion of the IS that has been through at least one review by the advisor.

A full final draft will be submitted to the advisor in the second semester of the Senior I.S. project.

### **Digital I.S. Copy**

The I.S. text (in PDF form) are provided digitally to the Registrar on or before I.S. Monday.

### **Poster**

This document represents the I.S. in poster form and will be presented during the Senior I.S. celebration day. It can be a traditional or digital in nature and students should consult their advisor about the format of their poster.

## **Formatting**

### **Overall Document**

Left margin 1.5 in (extra .25 in to allow for binding)

Right margin 1.25 in

Top margin 1 in

Bottom margin 1 in (page number will be about .5 in from the bottom edge of the paper)

Chapters start on a new page

Theorems, lemmas, examples, corollaries, definitions, propositions, remarks, notation, terminology, figures, and tables numbered within Chapters.

### **Title page** (no page number - everything centered except Advisors which are on left margin)

Title

Independent Study Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Bachelor of Arts in the Department of Mathematics and Computer Science at the College of Wooster

by

Author

The College of Wooster

Year

Advised by:

Advisors

### **Frontmatter** (Page numbers at bottom of pages)

Blank page hidden page number

Copyright page (optional and hidden page number)

Abstract (roman page number (ii or iii based on copyright or not))

Dedication (optional)

Acknowledgments (optional)

Vita (optional)

Table of Contents

List of Figures (only needed if there are figures)  
List of Tables (only needed if there are tables)  
List of Listings (only needed if there are code listings)  
Preface (optional) (A chapter which is not numbered or lettered)

### **Mainmatter**

Numbered Sections (Page numbers in arabic, first page number of chapter centered at bottom, remaining page numbers in upper right and running header on upper left (Chapter number Chapter title))  
Introduction (Chapter 1)  
Body (Chapters 2-?)

### **Backmatter**

**Lettered Sections** (Page numbers in arabic, first page number of appendix centered at bottom, remaining page numbers in upper right and running header on upper left (Appendix letter Appendix title))  
Appendices

### **Sections not lettered or numbered**

Afterword (optional)  
References  
Index (optional) (two column alphabetized)  
Colophon (optional)  
Blank page (hidden page number)

An example of a completed thesis can be seen in the LaTeX IS Guide found at <http://goo.gl/masj>

### **METHODOLOGY:**

The essential factor here is the degree to which the student has approached the project in an organized and efficient manner and has applied effort consistently throughout the entire year. The quality and promptness of intermediate submissions is highly important. A major item is the promptness and quality of the rough draft submission since it measures the ability of the student to effectively coordinate the research effort in an efficient manner. Attendance and presentation issues from the first semester will carry a heavy weight for this criterion.

### **ORAL PRESENTATION:**

Grading of the oral presentation evaluates the organization, spontaneity, flow, continuity, and comprehensibility of the presentation. It also evaluates the student's ability to respond to reasonable questions and explain points of confusion. The student should use visual aids as a means of guiding the presentation, but should avoid reading material to the audience. The presentation should last approximately thirty-five minutes to permit approximately fifteen minutes for questions and extended discussion. A major challenge of the presentation is to identify the key points to cover in giving a good description of the project in a relatively short time period.

### **Document Submission and oral presentation schedule.**

The student will meet with the advisor once a week to discuss ideas relating to the project, review progress, and map out work to be done. All Mathematical Science I.S. students will meet as a group to give a brief presentation of their work to that point (dates are below).

With the exception of the oral defense, the student will submit a typed document for each item by 4:00 PM on the indicated day. The student will submit the final thesis to the Registrar's office on the indicated day; all other documents will go to the advisor. Advisors will not discuss assignments with students on the day they are due or the day before. The schedule of submission is as follows:

## **Junior Year, Second Semester**

### **Friday of last week of classes - IS Preliminary Proposal**

Proposal form needs to be submitted to Department Chair.

## **Senior Year, FALL 2012**

### **Friday of 3rd week - Topic and Annotated bibliography**

An annotated bibliography is a list of citations to books, articles, and documents. Each citation is followed by a brief (usually about 150 words) descriptive and evaluative paragraph, the annotation. The purpose of the annotation is to inform the reader of the relevance, accuracy, and quality of the sources cited. Below is an example of one such citation that would appear:

Taalman, Laura. "Taking Sudoku Seriously." *Math Horizons*. September 2007, 5-7.

The author gives an overview to the Sudoku puzzle, including the rules and counting the number of possible Sudoku boards. It is an introductory article complete with concise terminology to use, mention of results about Sudoku and remaining open questions are included. Many of the primary resources in the article should be investigated and evaluated.

### **Friday of 6th week - Project Proposal - Description/Goals**

This is a one-page description of what your project will be about.

### **Friday of 12th week - A Comprehensive Narrative**

This could be a background exposition, a history chapter describing the general area of research, a literature review, or it may be a later chapter of the thesis. In any case, it should be a substantial written portion of the thesis.

### **Friday after Thanksgiving Break - Outline**

This should be a detailed outline of the thesis.

### **Tuesday of last week of classes - Oral presentation**

This should be a five-seven minute presentation on your project and progress in the first semester. Your presentation should make use of some form of presentation software.

**Grading, Fall Semester:**

Below are the components that will determine your IS grade for MATH 451 (usually completed in the fall semester of the Senior year). The due dates given earlier are suggestions and you will determine and record the actual due dates in consultation with your advisor. Each component is worth approximately 20% of your overall grade for MATH 451. Your grade on each component will reflect your promptness, clarity of presentation, thoroughness, and consistency with documents already submitted. To obtain a satisfactory progress (SP) grade in MATH 451, the student must complete all indicated submissions and receive at least an 81%. The table below suggests a 100 point scale but it is within the purview of the advisor to determine how they will measure successful progress and to communicate this to the student.

Project proposal and outline	_____	20 points
Oral presentation	_____	20 points
Subject and annotated bibliography	_____	20 points
Comprehensive narrative	_____	20 points
Attendance	_____	20 points

Grade for first semester:

SP: 81 to 100 points

NC: 0 to 80 points

**Senior Year, SPRING 2013**

**Tuesday of 1st week - IS Student meeting**

A meeting to remind students of formatting requirements and to answer any questions they may have.

**Friday of 1st week - Table of Contents and Second chapter**

A Table of Contents that should be close to the final product and another substantial written portion of the IS.

**Friday of 7th week - First complete draft**

Changes beyond this copy should only be editorial and only a minimum of new material should be written. See the IS Guidelines for formatting information.

**IS MONDAY - Final thesis**

**Oral**

TBD

**Grading, Spring Semester:**

The spring semester grade (H, G, S, NC) will largely represent an evaluation of the final thesis, the oral presentation, and the organization of the project effort. The following criteria determine the final grade. You should also look at the attached evaluation rubrics for the IS thesis and oral presentation.

**CONTENT:**

The content of the independent study document must meet the requirements agreed upon by the IS advisor and advisee. These requirements will differ for each project.

**FORM:**

The final independent study document is evaluated for mechanical and grammatical errors. The text must be well organized, grammatically correct, and complete - including a table of contents, an introductory and conclusion chapter, a bibliography, and a user manual if necessary.

**RUBRIC USED BY FACULTY FOR EVALUATION OF I.S. ORAL PRESENTATION**

Student:  
 I.S Title:  
 Advisor:  
 Form Completed by:  
 Date of Oral Presentation:

**Directions:** Please rate the presenter on each aspect of the presentation, using this scale:

E-excellent      G-good              A-average              F-fair              P-poor              NO-not observed

INTRODUCTION						
Introduced the topic clearly	E	G	A	F	P	NO
Provided motivation for the study	E	G	A	F	P	NO
Introduced the terminology in an organized manner	E	G	A	F	P	NO
Explained all necessary definitions	E	G	A	F	P	NO
BODY						
Presented major results correctly and accurately	E	G	A	F	P	NO
Communicated with correct mathematical reasoning	E	G	A	F	P	NO
Provided adequate support for any conclusions that were drawn	E	G	A	F	P	NO
Summarized major points	E	G	A	F	P	NO
DELIVERY						
Voice and pace	E	G	A	F	P	NO
Language was clear and concise	E	G	A	F	P	NO
Used appropriate, high-quality visuals	E	G	A	F	P	NO
Body language, mannerisms	E	G	A	F	P	NO
Professionalism, audience awareness	E	G	A	F	P	NO
OVERALL EVALUATION						
Showed thorough understanding of the topic	E	G	A	F	P	NO
Talk was completed within an appropriate time frame	E	G	A	F	P	NO
Answered questions well	E	G	A	F	P	NO

Comments:

## **Math 452 Evaluation Rubric** (revised fall 2012)

This rubric serves as a starting point for discussion among the mathematics faculty about Math 452 grades. Not all questions apply equally well to every project, and some are only appropriate for the first reader. Roughly speaking, a score of 4 in an area corresponds to Honors-level achievement, 3 to Good, and 2 to Satisfactory, with 1 and 0 indicating substandard performance. However, the way in which these elements are weighted is topic-dependent, and a particular set of scores does not guarantee a certain 452 grade. For double majors, the evaluation of the project from the perspective of the other discipline is also significant in determining the grade.

**1. Extent of Material Covered** – Based on the material covered in the final written document and (for first readers only) your weekly meetings with the student, which statement best describes the extent of the student’s investigation? (Use 1a for all projects, and also 1b if it applies.)

**1a. Extent of Investigation** – Which statement best describes the extent of the student’s investigation?

- **(4 - Exceptional)** The student did a thorough investigation into a focused topic, providing examples and going well beyond the minimum extent required of a two-semester project.
- **(3 - Strong)** The student did a comprehensive summary of a focused topic, providing examples and personalizing the material.
- **(2 - Adequate)** The student did a good summary of material pertaining to a defined topic, and the extent is sufficient for a two-semester investigation.
- **(1 - Marginal)** The student covered some portions well, but failed to go far enough with others, and/or lacked a topical focus.
- **(0 - Unsatisfactory)** The student provided a brief summary of the material, but the extent was insufficient for a two-semester investigation and/or the content was so widely scattered as to make the central topic unclear.

**1b. Extent of Application** – If applicable, which statement best describes the student’s mathematical modeling?

- **(4 - Exceptional)** The student has a thorough understanding of the application area, which is reflected with originality in an innovative model.
- **(3 - Strong)** The student has a thorough understanding of the application area, and all key aspects are reflected in the model.
- **(2 - Adequate)** The student has an understanding of the application area, with some key aspects reflected in the model.
- **(1 - Marginal)** The student has a weak understanding of the application area, resulting in a deficient model.
- **(0 - Unsatisfactory)** The student has a clear lack of understanding of the application area, resulting in a poorly-designed model.

**2. Appropriate Use of Resources** (Use one or both parts, based on their applicability to the student’s project.)

**2a. Use of Prior Literature** – Allowing for differences based on mathematical subfields and the topic of the student’s investigation, which statement best describes the use of related prior literature in the thesis?

- **(4 - Exceptional)** The student used appropriate resources, integrated them into one coherent narrative, and understands the place of their own work in the context of the wider subfield of mathematics.
- **(3 - Strong)** The student successfully used appropriate resources, and some integration is apparent in the thesis.
- **(2 - Adequate)** The student successfully used appropriate resources.
- **(1 - Marginal)** The student’s use of resources is somewhat inadequate.
- **(0 - Unsatisfactory)** The student’s use of resources is substantially inadequate, significantly impacting the quality of the thesis.

**2b. Use of Computational Tools** – Which statement best describes the student’s use and justification of computational methods used in this investigation?

- **(4 - Exceptional)** The student successfully used appropriate computational tools, and fully justified them (through literature review and/or preliminary investigation).
- **(3 - Strong)** The student successfully used appropriate computational tools, and mostly justified their use.
- **(2 - Adequate)** The student successfully used appropriate computational tools, but the justification is weak.
- **(1 - Marginal)** The student used inappropriate computational tools, did not justify their selection, and/or was only partially successful in using them.
- **(0 - Unsatisfactory)** The student was unsuccessful in using computational tools.

3. **Writing Quality** – Which statement best describes the quality of the student’s writing in the thesis, including organization, readability, mathematical precision, form (grammar, spelling, typesetting), and style?

- **(4 - Exceptional)** The I.S. is written in a clear, precise well-organized manner, with excellent form. Moreover, it is written in the student’s unique style and directed toward an audience of peers.
- **(3 - Strong)** The I.S. is well-organized and very readable, with only minimal errors in any of these areas.
- **(2 - Adequate)** The I.S. is well-organized and readable, despite some lack of precision and/or errors in form.
- **(1 - Marginal)** The I.S. is somewhat difficult to read, because of weak organization and/or significant issues in form or precision.
- **(0 - Unsatisfactory)** The I.S. is quite difficult to read, because of disorganization and/or pervasive issues in one or more of these areas.

4. **Presentation** – Which statement best describes the quality of the student’s final oral presentation, considering organization, knowledge of content, audience awareness, and professionalism? (For double majors whose oral exam begins from a poster, rather than an oral presentation, consider the poster instead.)

- **(4 - Exceptional)** The presentation was excellent overall, and strong in each of these aspects.
- **(3 - Strong)** The presentation was solid, with only minimal problems in any of these aspects.
- **(2 - Adequate)** The presentation was acceptable, despite some weakness in one or more aspects.
- **(1 - Marginal)** The presentation was substantially hampered by a pronounced weakness in at least one aspect.
- **(0 - Unsatisfactory)** The presentation was unacceptable, with pronounced weaknesses in multiple aspects.

5. **Independence of Learning** (for first readers only) – Based on the weekly meetings with your I.S. student, which statement best describes the student’s initiative and independence throughout the process?

- **(4 - Exceptional)** The student demonstrated strong initiative and independence, requiring only a minimal amount of guidance.
- **(3 - Strong)** The student demonstrated good initiative and worked mostly independently, requiring an appropriate amount of guidance.
- **(2 - Adequate)** The student was self-directed for some of the thesis, but required lots of guidance on other parts.
- **(1 - Marginal)** The student was unable to work without strict deadlines and lots of guidance regarding the direction of the thesis.
- **(0 - Unsatisfactory)** Despite deadlines and guidance from the advisor, the student failed to complete work in a timely manner.

6. **Student Understanding and Mastery of the Subject** – Based on the written thesis, the oral examination, and (for first readers only) weekly meetings, which statement best describes this student’s understanding of the content in the I.S.?

- **(4 - Exceptional)** The student has a thorough understanding of the material and was able to answer nearly all probing questions.
- **(3 - Strong)** The student has a good understanding of the material was able to answer questions in all areas of content, including some probing questions.
- **(2 - Adequate)** The student has a good understanding of most of the material, but had difficulty answering probing questions.
- **(1 - Marginal)** The student lacks understanding of significant portions of the material, and had difficulty answering most questions.
- **(0 - Unsatisfactory)** The student lacks a basic understanding of the material and was unable to answer basic questions.