PROFESSOR

Dr. Rebekah B. Johnson Yates
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In person is the best way to contact me. Email is the next best way.

WEBPAGE

All course assignments and information will be posted on our course webpage `https://facultysites.houghton.edu/rebekahyates/MathSeniorSeminar.html` .

LOCATION/TIME

TR 2:30–3:20 PM in Library 140

TEXTS (REQUIRED)

Mathematics: The Loss of Certainty by Morris Kline, published by Oxford University Press
Mathematics for Human Flourishing by Francis Su, published by Yale University Press
How to Bake π: An Edible Exploration of the Mathematics of Mathematics by Eugenia Cheng, published by Basic Books

DESCRIPTION

From the catalog: "A capstone course that further develops problem solving and mathematical communication skills. Emphases on formulating, solving, and explaining challenging problems in both verbal and written form to a variety of audiences. Considers the relationship of mathematics to various other disciplines, the historical development of mathematics, and the relationship between mathematics and the Christian faith. For seniors, except by permission. Liberal Arts." 2 credits.

COURSE GOALS AND OBJECTIVES

As the capstone course in mathematics, this course is intended to further develop your problem solving and mathematical communication skills (reading, writing, and speaking) and to review and unite the various areas of mathematics you have studied as a mathematics major at Houghton.

In the setting of a liberal arts college, we must also consider the relationship of mathematics to various other disciplines, including the historical development of mathematics, the effects of various philosophies on mathematics, the uses of mathematics for application in other disciplines, and the artistic and humanistic side of mathematics. This should draw on your learning in all your other courses at Houghton as well. And because Houghton is a Christian college, we are also able to discuss relationships between mathematics and the Christian faith.

Throughout all of this, you should be growing in independence in your mathematical skills as you take more initiative for your own learning. To that end, you should increase your ability to learn more by asking questions and seeking answers, learn how to find and use resources for to ask and answer such questions, further develop your skills in analyzing ideas and arguments, and improve in your ability to express your own ideas orally and in writing.

PROGRAM OUTCOMES

The mathematics faculty have developed the following goals for Houghton math majors, all of which will be assessed in this capstone course:

- Effective Thinking and Communication: Students will develop effective mathematical thinking and communication skills.

- Liberal Arts: Students will explore and articulate ways in which mathematics is essential to a liberal arts education and informs and enriches a Christian life.

- Persistence: Students will experience open-ended inquiry and demonstrate persistence in solving problems.

- Independent Work: Students will develop the ability to solve a variety of mathematical problems independently.

- Collaborative Effort: Students will develop the ability to collaborate with others in solving mathematical problems.

- People and History: Students will be able to identify several significant mathematicians, some of their contributions, and how these contributions impacted mathematics, other disciplines and culture.

- Content Knowledge: Students will demonstrate understanding of core content in calculus, linear algebra, abstract algebra, and real analysis.

INSTITUTIONAL OUTCOMES

Learning in this course addresses the following Houghton Essential Learning Outcomes addresses the following Houghton College Essential Learning Outcomes: Christian faith, written communication, oral communication, critical thinking, logical & quantitative reasoning, information literacy, diverse perspectives, and ethical reasoning.

GROUP PROJECT

In a group of 2 or 3, you will research a specific topic/moment in history in the field of mathematics (problem, concept, person, etc.) that demonstrates how mathematics contributes to human flourishing via the virtues and desires discussed in *Mathematics for Human Flourishing*, write an expository paper, and present the mathematics, history, and current state thereof to a general audience in Math and Science Colloquium on **Tuesday, March 18**. Your project grade will be based on the quality of your research, your presentation, your paper, and your peer reviews of other groups' papers and presentations.

INDIVIDUAL PROJECT

You will complete an individual project on a topic or problem in mathematics, present the project to an audience of your mathematical peers (this class and possibly other math majors/math interested students who attend the presentations), and write a paper about the topic/problem, incorporating any feedback you receive from me and your peer reviewers. You may select one of these options for your individual project:

1. Choose a problem from a completed Putnam Competition exam. Find a solution for the problem online and rewrite the solution filling in all the missing details as well as any necessary background information. Propose at least two of your own extensions to the problem and solve at least one of the extensions. Your grade will be based on the quality of your explication, extensions, and solutions.

2. Choose a paper from a peer-reviewed mathematical journal on a topic that interests you. Write an explication of the paper, including your own original examples of concepts in the paper. Propose at least two further directions for research based on the paper topic and pursue one of them yourself as far as possible in the time frame.

Further details on the project, including due dates for various stages, will be distributed in class and posted on the course webpage.

INTEGRATION PAPER

You will write a 4–5 page (single-spaced) paper integrating your mathematical experiences, your liberal arts education, the Christian faith, your mathematical reading, and your research addressing the questions

- What is the nature of mathematics?

- How does mathematics grow and develop?

- How can mathematics and the Christian faith inform and enrich each other?

MATHEMATICAL JOURNAL

You will keep a journal of mathematical experiences throughout the semester. At the end of the semester, you should have at least five substantive entries that include both summary and reflection. This journal will record mathematical experiences you have this semester, not those you've had in your mathematical past (though entries may relate your current experience to your previous experiences). It is your responsibility to seek out and record these experiences. Examples of acceptable mathematical experiences include reading a math article or book not required for a class, researching a mathematical career and giving a brief presentation on it to the class or another class as arranged with the professor, watching a math movie (check with me on whether a particular movie qualifies), going to a mathematical art exhibit, learning about an area of math that is new to you, going to a K–12 classroom and giving the class a mathematical experience, making yourself a webpage complete with résumé, etc. If you are unsure if a particular experience is a viable option for your journal, please check with me. This journal will be due and discussed at the final exam period, though you should work on it throughout the semester.

Reading Assignments

You will have many reading assignments. For each assignment, you should do the following:

(a) Read and respond: read the assigned material, rereading as needed. In preparation for building our class discussion, write down your observations, things that you find interesting, connections that you see with your learning in other classes (math and non-math classes), etc., and respond to the assigned reading questions.

(b) Ask questions: Write down your own questions from the reading and be ready to ask the questions in class. Examples of things you may have questions about: new or old concepts that are confusing to you, connections to other ideas, examples you thought of, misconceptions that were clarified, etc. You should consider recording what you found to be explained well in the reading, what was interesting, was what confusing, and what required rereading but you eventually understood.

(c) Quantify: record how much time you spent on each reading assignment.

You will turn in your reading responses at the end of each class discussion on the readings.

Class Time

You are expected to actively participate in every class. You will submit a proposed class participation grade, with justification, at the end of the semester, taking into account each of the following aspects of class participation. I will determine your final participation grade.

- Attendance: Come to class on time and be engaged in class for the entire class time. Please let me know (in writing or in person) if and why you will be missing a class. Each absence after the first will reduce your letter grade by $\frac{1}{3}$ (e.g., an A reduces to an A$-$).

- Reading and Questions: See the separate section above on Reading Assignments.

- Problem Solving: We will work on problems in class sometimes; you will be expected to fully participate in solving these problems.

- Feedback for Classmates: Full participation in the peer review process is an integral part of the course. You are expected to give thoughtful and helpful feedback to your classmates and graciously accept feedback given to you, incorporating it into your final products.

Assessment

Your grade will be based on the group project (30%), your individual project (30%), your integration paper (15%), in-class work/participation/reading responses (15%), and your mathematical journal (10%). I reserve the right to change the percentage distribution as the class progresses.

Technology in the Classroom

Other than using laptops for presentations on specified days, we will be practicing an electronic-device-free classroom in order to engage deeply with the material and each other. Please turn off your computers, cell phones, and smart watches and stow them in your bag upon entering the classroom and leave them there for the duration of the class unless instructed to use a device.

Academic Integrity

Honesty is the foundation on which all intellectual endeavors rest. To use the ideas of others without acknowledging the authors of those ideas belies the nature and purpose of academic life. At Houghton, where we strive to live out Christian calling and commitment, personal integrity, including academic honesty, should be the hallmark of all our work and relationships. Houghton's full Academic Integrity Policy, including procedures for addressing violations, can be found in the Academic Catalog: `https://www.houghton.edu/undergraduate/majors/academics/catalog/`
Any work or writing you turn in should be your own, and you are responsible for ensuring that you do not copy anyone else's work or writing (this includes not copying things from the internet or using generative AI).

Accommodations

If you have an academic or physical disability that requires accommodations please contact the Academic Support and Accessibility Services in the Center for Student Success located on the first floor of the Chamberlain Center (585–567–9622). With appropriate documentation, you will be afforded the necessary accommodations. For more information about Academic Support and Accessibility Services go to `https://www.houghton.edu/undergraduate/student-life/student-success/`.

TIME
COMMITMENT   In accordance with the guidelines of 2–3 hours of work per week for each credit hour for a course, the well-prepared student should spend approximately 4–6 hours of work per week beyond the time spent in class. If you find that you are spending significantly more time than this, please let me know so that I can help you be more efficient and effective in your learning or adjust the workload. If you are spending less time than this, you may not be investing enough time to learn well.

Tentative Schedule

TUESDAY		THURSDAY	
Jan 14 Introduction	**1**	16 Kline Intro, Ch. 1, Ch. 2 through the first full paragraph on page 35	**2**
21 Kline rest of Ch. 2 and Ch. 3	**3**	23 Kline Ch. 4	**4**
28 Kline Ch. 5	**5**	30 Kline Ch. 6 **Group and Topic for Project**	**6**
Feb 4 Kline Ch. 7–8	**7**	6 Kline Ch. 9–10 up to the end of the first full paragraph on page 230 **Group Project Sources and Refined Topic**	**8**
11 Kline rest of Ch. 10–11	**9**	13 Kline Ch. 12–13	**10**
18 Cheng Prologue, Ch. 1 and Ch. 2	**11**	20 Cheng Ch. 3 and Ch. 4 **Individual Project Options Presentations**	**12**
25 Cheng Ch. 5 and 6	**13**	27 Cheng Ch. 7 and 8 **Group Project Paper Draft due** **Individual Project Choice due Friday**	**14**
Mar 4 Spring Break	**15**	6 Spring Break	**16**
11 Group Project Work Day **Peer Reviews of Group Project Papers due**	**17**	13 Practice Colloquium Presentations	**18**

Tuesday		Thursday	
18 **19** **Colloquium 11:30–12:20**		20 **20** Math: What Is it Good for? **Project Paper Final Draft due**	
25 **21** Su preface, Ch. 1, 2		27 **22** Su Ch. 3, 4, 5	
Apr 1 **23** Su Ch. 6, 7		3 **24** Su Ch. 8, 9 **Individual Project step 3 should be done around now**	
8 **25** Su Ch. 10, 11		10 **26** Su Ch. 12, 13 and epilogue	
15 **27** MFT practice **Individual Project Paper Draft due**		17 **28** Maundy Thursday (Easter Break)	
22 **29** MFT practice		24 **30** Major Field Test **Peer Reviews of Individual Project Papers due**	
29 **31** Major Field Test		May 1 **32** Individual Problem Presentations	

Due at the final period on Tuesday, May 6 at 1:30 PM: Individual Problem Paper, Integration Paper, Mathematical Journal, Participation Grade Proposal. We will also have the remaining individual problem presentations during the final period.