Explorations in Modern Mathematics

Syllabus version 1.0 (Updated: January 7, 2021)

Course Information

- **Institution**: Dordt University
- **Course**: Math 149-01 (3 cr.)
- **Term**: Spring 2021
- **Instructor**: Dr. Mike Janssen, Associate Professor of Mathematics
- **Classroom**: CL 2241
- **Class time**: 1:00-1:50pm MWF
- **Office**: SB 1612
- **Student Hours**: Make an appointment or drop by
- **Course notes**: https://prof.mkjanssen.org/emm/notes/ | PreTeXt source
- **Course website**: https://prof.mkjanssen.org/emm/
- **Catalog Course Description**: This course is focused on exploring college-level mathematics relevant for all students, regardless of discipline. We will investigate modern mathematical topics including number theory, modeling, fractals, infinity, probability, making meaning from data, and decision-making. Mathematical thinking, reasoning, and pattern discovery will be particularly emphasized. A guided discovery approach will be utilized, and we will discuss how a Reformed perspective impacts our view of the quantitative world. **Prerequisite**: an ACT mathematics score of 22 or higher or satisfactory completion of one course from Mathematics 100, 108, 115.

Required resources

- Access to the course notes
- One 3x3 Rubik's cube (any cube will do, but here is an inexpensive recommendation)
- A copy of *Mathematics for Human Flourishing*, by Francis Su

Learning Objectives

In this course, students will

- be *communicators* by working together in groups on mathematical puzzles and sharing their thinking with the class. (CD)
- be *explorers* by playing with God's mathematical creation, explicitly with the Rubik's cube, and implicitly with other puzzles and problems. (CS)
- be *connectors* by exploring the power and limitations of mathematics for modeling the physical creation, and applying mathematical thinking to articulate a vision for a more just society. Stu-

dents will also explore the notion of mathematical truth, and assess its place in understanding God's creation. (RO, CS, CR)
- be *ambassadors* by identifying, analyzing, and presenting on an aspect of beauty in mathematics. (RO, CS)

Assignments

The best way to learn mathematics is to *do* mathematics, and so we will regularly engage in the following items of work to strengthen our mathematical muscles.

In-Class Explorations The heart of this course is the in-class work. Our class meetings will typically start with a short (5-10 minutes) introduction to the main questions under consideration. You'll then work in assigned groups of approximately 3 to explore the activities posted to the course notes for the day. We'll wrap up with discussions of whatever you found the most interesting, as well as some big-picture takeaways.

This mode of instruction is **highly interactive; it is therefore essential that you participate in class each day** (see also Flexible Course Design below for COVID contingency plans). Group participation will be monitored, and groups will regularly share their thinking with the class.

Weekly Checkpoints On most Fridays on which we do not have a thematic checkpoint, we'll end class with a short *weekly checkpoint* (approximately 5 points). The purpose of the weekly checkpoint is to get a sense of how well you're understanding the material we discussed that week. They also have space for you to ask questions about the class; points will be awarded for both questions asked and answered.

Thematic Checkpoints At the conclusion of each theme (e.g., *Play*, *Truth*, etc), we'll have a larger thematic checkpoint. The standard format will be as a 50-point "exam", but there are exceptions to this (such as the Play checkpoint, which will be a solve of the Rubik's cube, or the Power checkpoint, which will be a presentation of the results of our graph-theoretic analysis of human trafficking networks). The thematic checkpoints will be held on:

- Play: February 5 (though you will have until February 26 to complete your Rubik's cube solve)
- Truth: February 22
- Justice: March 15
- Power: April 23

Reading Reflections/Discussions Along the way, we'll read Francis Su's *Mathematics for Human Flourishing*, and consider the ways in which the practice of mathematics can help us lead lives of *shalom*. After reading a set of chapters, you'll write a short (less than 3 pages) response to the ideas therein. A few days later, we'll have an in-class discussion in small groups. Due dates are:

- Chapters 1-5: reflection due February 1, class discussion on February 3
- Chapters 6-7: reflection due February 19, class discussion on February 24
- Chapters 8-11: reflection due March 22, class discussion on March 24
- Chapters 12-13, Epilogue: reflection due April 21, class discussion on April 26

Final Project The final project will highlight some aspect of beauty in mathematics. You may choose to work with others. There are several steps to completing the project:

1. **Rank the topics** (10% of project grade): You will be presented with a list of possible topics (including space to propose your own) and asked to rank them in order from most to least interesting. Your topic will be assigned based on your rankings in such a way that no one gets the same project topic. **Due March 19.**
2. **Preliminary Report** (20% of project grade): By April 2, you will submit a 1-2 page description of what you have learned about your topic, what questions you still have, and what artifact you are planning to create. **Due April 2.**
3. **Artifact** (50% of project grade): By April 30 (last day of class), you will create something that communicates or otherwise explores *meaningful* mathematics in your topic. That is, you should go deeper than just a surface-level understanding. You have freedom in what, exactly, you create. Here are some preapproved artifacts:
    - *A work of fine, visual, or literary art, with a 300-450 word interpretive guide*. You can make or write something that explores the mathematical idea. Much of the work of your interpretive guide is in helping your audience understand the significant mathematics that is being explored so that we can better grasp your work.
    - *A research paper and slide deck*. If you are not so keen to create a work of art, perhaps you'd rather write an 1800-2400 word research paper describing the mathematics you explored, as well as its history and why it is thought to be beautiful. You will cite at least five (5) reputable edited sources and format your paper using MLA guidelines. You should also prepare a short (3-5 minute) slide deck for the presentation (see below).
    - *A lesson plan and activity*. If education is your thing, maybe you'd like to create a lesson plan using the full Dordt Education Department lesson plan template that introduces the students you hope to teach to your particular topic (e.g., if you are hoping to teach middle-level students, aim it at 6-8th graders). You should also create the activity that you would use to help these students explore the topic, as well as a short slide deck to help our class understand your topic and what you'll ask the students to do.
    - *Other*. In your topic rankings, you may propose to do something not on this list. You should carefully describe what you will do so that I have a clear sense that it will be roughly equivalent in depth and workload to the preapproved options. If I don't think it is, I will either ask for clarification, suggest an alternative based on your idea, or assign you to one of the preapproved options.
4. **Presentation** (20% of your project grade): By the last day of class (April 30), you will submit plans for a short (less than 5 minutes) presentation. We will give our final presentations in person during our assigned final exam slot (TBA).

Flexible Course Design

Assuming Dr. Janssen is not in quarantine/isolation, and less than 40% of the class is not in quarantine/isolation, class discussion will be recorded in screencast format and posted to the day's notes homepage shortly after class. Students in quarantine or isolation will participate asynchronously. We will follow the day's notes very closely to ease the burden of remote participation.

If Dr. Janssen is in quarantine/isolation and otherwise feels healthy, or more than 40% of the class is in quarantine/isolation, we will hold synchronous class meetings over Zoom, utilizing breakout rooms for groupwork.

If Dr. Janssen is ill, activities will be posted on the day's homepage for independent/group work.

Grading

Your final percentage G will be calculated according to the following weights.

Category	Weight
Attendance and Participation	10%
Weekly Checkpoints	15%
Thematic Checkpoints	40%
Reading Reflections	15%
Final Project	20%

Your final grade will then be assigned based on this scale:

Grade	Interval
A	$92\% \leq G \leq 100\%$
A-	$90\% \leq G < 92\%$
B+	$87\% \leq G < 90\%$
B	$83\% \leq G < 87\%$
B-	$80\% \leq G < 83\%$
C+	$77\% \leq G < 80\%$
C	$73\% \leq G < 77\%$
C-	$70\% \leq G < 73\%$
D+	$67\% \leq G < 70\%$
D	$63\% \leq G < 67\%$
D-	$60\% \leq G < 63\%$

Other Polices and Advice

- I am generally fairly accepting of late work, with a built-in 24-hour grace period for any non-classroom activities. Additional time beyond the 24-hour grace period must be approved ahead of time.
- Student hours are your time to ask questions about all aspects of the class and college life. If you can't find an appointment, send me an email! I will do my very best to accommodate your schedule.
- **Email Policy**: I check my email twice per school day: once in the morning, where I'll deal with any emergencies, and once in the afternoon, when I'll respond to other emails (including any that have come in since the morning). If you require a more immediate response, you're welcome to come find me in my office.

Additional Information

Dordt University Student's Right to Accommodations Policy Any student who needs access to accommodations based on the impact of a documented disability should contact the Coordinator

of Services for Students with Disabilities (CSSD): Marliss Van Der Zwaag, Academic Enrichment Center, (712) 722-6490, marliss.vanderzwaag@dordt.edu.

Dordt University Academic Dishonesty Policy Dordt University is committed to developing a community of Christian scholars where all members accept the responsibility of practicing personal and academic integrity in obedience to biblical teaching. For students, this means not lying, cheating, or stealing others' work to gain academic advantage; it also means opposing academic dishonesty. Students found to be academically dishonest will receive academic sanctions from their professor (from a failing grade on the particular academic task to a failing grade in the course) and will be reported to the Student Life Committee for possible institutional sanctions (from a warning to dismissal from the university). Appeals in such matters will be handled by the student disciplinary process. For more information, see the Student Handbook.

COVID-19 Classroom Protocols As we begin the semester, Dordt is a mask-required environment. While on Dordt's campus, you will need to wear a mask in all public places or common indoor spaces, which include: classrooms, hallways, laboratories, restrooms, the Hulst Library and all building lobbies. Should you forget your mask, there may be a disposable paper mask available in the classroom/lab for your use. If not, your instructor will ask you to return to your room to retrieve your mask. Physical distancing practices will also be in effect. Your instructor may also ask for student volunteers to who are willing to take a few minutes to spray cleaning solution on classroom surfaces when class concludes.

If you are approved by Student Services for accommodations for virtual learning due to COVID-19, your instructor will be notified by Student Services and you will receive information from your instructor about virtual learning during your isolation period.

Tentative Schedule

I aim to build a dynamic classroom; as such, the schedule below may be changed as the semester progresses. Any changes will be reflected here and in the course notes.

Week	Day	Topic	Work Due
1	15-Jan	Course intro	WCP 1
2	18-Jan	All about cubies	
2	20-Jan	Challenge Day I	
2	22-Jan	Challenge Day II	WCP 2
3	25-Jan	Notation and Order	
3	27-Jan	Magic Cube Moves I	
3	29-Jan	Magic Cube Moves II	WCP 3
4	1-Feb	Magic Cube Moves III-IV	M4HF Reflection: Chs. 1-5
4	3-Feb	**Reading discussion**; Truth and Inductive Reasoning	
4	5-Feb	**Thematic Checkpoint 1**	**Thematic Checkpoint 1**
5	8-Feb	Axioms	
5	10-Feb	Deductive Reasoning	
5	12-Feb	Formal Logic	WCP 4
6	15-Feb	**No class**	

Week	Day	Topic	Work Due
6	17-Feb	The Foundational Crisis of Mathematics	
6	19-Feb	Infinity and Incompleteness	WCP 5; M4HF Reflection: Chs. 6-7
7	22-Feb	**Thematic Checkpoint 2**	**Thematic Checkpoint 2**
7	24-Feb	**Reading discussion**; Apportionment I	
7	26-Feb	Apportionment II	WCP 6; Final in-office attempt at Thematic Checkpoint 1
8	1-Mar	Apportionment III	
8	3-Mar	Electoral College I	
8	5-Mar	Electoral College II	WCP 7
9	8-Mar	Electoral College III	
9	10-Mar	Electoral College IV	
9	12-Mar	Math and Democracy Conclusion	WCP 8
10	15-Mar	**Thematic Checkpoint 3**	**Thematic Checkpoint 3**
10	17-Mar	Discrete Dynamical Systems I	
10	19-Mar	Discrete Dynamical Systems II	WCP 9; Project ranking due
11	22-Mar	Discrete Dynamical Systems III	M4HF Reflection: Chs. 8-11
11	24-Mar	**Reading discussion**; Discrete Dynamical Systems IV	
11	26-Mar	Discrete Dynamical Systems V	WCP 10
12	29-Mar	Discrete Dynamical Systems VI	
12	31-Mar	Graph Theory I	
12	2-Apr	Graph Theory II	WCP 11; Preliminary Report due
13	5-Apr	Graph Theory III	
13	7-Apr	**No class**	
13	9-Apr	Graph Theory IV	WCP 12
14	12-Apr	Graph Theory V	
14	14-Apr	Graph Theory VI	
14	16-Apr	HT Lab	WCP 13
15	19-Apr	HT Lab	
15	21-Apr	HT Lab	M4HF Reflection: Chs. 12-13, Epilogue
15	23-Apr	**Thematic Checkpoint 4**	**Thematic Checkpoint 4**
16	26-Apr	**Reading discussion**; Fractal Geometry I	
16	28-Apr	Fractal Geometry II	
16	30-Apr	Fractal Geometry III	WCP 14
Finals		Mathematical beauty presentations	