Math 131: Discrete Mathematics **2023**

Discrete Mathematics, Epp, Chapters 1-7,10

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office hours sign up for 15 min appts at calendly.com/minton/15min

Course Objectives: *Continue to learn mathematics*! Discrete mathematics is an introduction to proofs. Proofs, in turn, reflect the critical thinking skills, precision and rigor that characterize mathematics and programming. Logical deduction is critical in any number of disciplines: a Roanoke grad who finished second in his class at Duke Law School credits discrete mathematics as the most important undergraduate course he took. The main objectives of this course are to improve your thinking skills to enhance your success in whatever your profession becomes, and to enjoy the problem-solving process.

Intended Learning Outcomes: At the end of the course, successful students will be able to

- Describe and apply each of several methods of mathematical proof
- Analyze a logical argument, and identify and correct any logical fallacies
- State and prove fundamental facts in number theory and graph theory
- Apply recursive relations to construct and prove facts about sequences

Equipment: This is a thinking course. We will not use Mathematica or other software to any significant degree. It is always a good idea to take notes. The act of writing down an idea gives you a muscle memory that helps your recall of the idea.

Attendance Policy: Regular attendance is expected. You must keep up with definitions! You are responsible for everything done in class. If you miss a class, e-mail or call me before class is over and explain why. **If you have two unexplained absences, you may be dropped from the course after a warning email is sent.**

I expect you to spend at least 12 hours of work each week inside and outside of class.

Academic Integrity: The college policy is fully supported. Quizzes are closed notes, closed book. Portfolio problems may be discussed in class, and you may always ask me for help. **Do not** collaborate on portfolio problems. No electronic devices are allowed in a test situation.

Study problems: Problems from each section of the book will be suggested. These are not to be turned in, but you should work each problem and ask questions about the ones you have trouble with. Study problems indicate the types of problems you will see on quizzes, and will help you prepare for portfolio problems.

Worksheet problems: On most days, a worksheet will be given during class. Turn these in for a grade, which will be 0 (not turned in), 1 (something), or 2 (basically correct).

Quizzes: There will be six quizzes. Each quiz will cover all material discussed before the day of the quiz. since the previous test. Quiz problems will typically be computational problems or very basic proofs. Anticipated quiz dates are 1/27, 2/10, 2/24, 3/22, 4/5, and 4/21.
The exam is Monday, May 1, 2:00-5:00.

Make-ups: In case of sickness or scheduling conflicts for quizzes, get in touch with me ASAP.

Co-Curricular: During the course of the semester, you must attend at least two approved co-curricular events offered by the MCSP department. For each, write a two-paragraph description of the event. Schedules for the talks can be found in Trexler hallways and at https://www.roanoke.edu/inside/a-z_index/math_cs_and_physics/conversation_series/spring_2023

Grading: Worksheets and co-curricular count 20%. Quizzes count 30%. The midterm portfolio counts 20% and the final portfolio counts 30%. Grades may be curved up based on participation, one unusually low quiz score or some other extenuating circumstance.
A: 93-100 A-: 90-92
B+: 87-89 B : 83-86 B-: 80-82
C+: 77-79 C: 73-76 C-: 70-72
D+: 67-69 D: 63-67 D-: 60-62 F: 59 and below

Subject Tutoring, located on the lower level of Fintel Library (Room 5), is open 4-9 PM, Sunday-Thursday. Subject Tutors are highly trained, current students who offer free, one-on-one (and small group) tutorials in over 80 courses taught at Roanoke College, including: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, and Social Sciences. Check out all available subjects and schedule 30- or 60-minute appointments at www.roanoke.edu/tutoring. If you have a question, feel free to stop by, or contact us at subject_tutoring@roanoke.edu or 540-375-2590. See you soon!

Accessible Education Services (AES) is located in the Goode-Pasfield Center for Learning and Teaching in **Fintel Library**. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

Student Health & Counseling Services supports students through in-person health appointments, in-person counseling, 24/7 telehealth (TimelyCare), Therapy Assistance Online, as well as resources related to general wellness, LGBTQ+, sexual assault, substance abuse, and suicide prevention. Unmet health needs can negatively impact your performance in this course. Student Health & Counseling Services can help. Please see https://www.roanoke.edu/shcs for more information and to access services.

Extra Credit: You may earn extra credit in a number of ways. My intent is to encourage you to have fun with mathematics, and that is the grading criterion that I will use – so have fun learning! You may check out from the Roanoke College library and report on "popular" mathematics books. You may report on mathematical web sites that have good mathematics demonstrations or extra material. The main rule here is to do this now; waiting until the end of the semester will make it hard to get much credit and (more importantly) distract you from the end-of-semester work that you need to do.

Date	Topic	Section	Study
1/18	Introduction	1.2	p.6 #5-9 p.14 #7-10
1/20	Functions	1.3	p.22 #5-10
1/23	Logical Form	2.1	p.51 #6-8,12-15,21-23,25-28
1/25	Conditionals	2.2	p.63 #5-8,16-18,20-23,34-36
1/27	Arguments	2.3	p.76 #1-2,7-10,24-30 **QUIZ #1**
1/30	Logic Circuits	2.4	p.91 #3-4,7-8,11-12,15-16,18-19,30-31
2/3			**QUIZ due**
2/6	Quantified I	3.1	p.119 #2,5-7,9-12,14,16,19
2/8	Quantified II	3.2	p.129 #3-6,17-21,25,34
2/10	Multiple Qs	3.3	p.143 #11-16,21-22,29-31,41 **QUIZ #2**
2/13	Q arguments	3.4	p.157 #5-10,21-24,28-31
2/15	Direct Proof	4.1	p.171 #3-6,10-11,15-18,23-26,30-31
2/17	Rationals	4.3	p.188 #13-19,24-26,35-38
2/20	Divisibility	4.4	p.197 #9-13,15-17,21-26,41,43
2/22	Division Into Cases	4.5	p.209 #9-10,13-19,25-28,35-39
2/24	Floor, Ceiling	4.6	p.217 #6-10,18-21 **QUIZ #3**
2/27	Contradiction	4.7	p.225 #5-7,11-14,17-19,26-28
3/1	Famous Theorems	4.8	p.233 #9-15,22,35-36
3/3	Handshake	4.9	p.242 #3-10,14-15
	SPRING BREAK!		

Midterm Portfolio Topics

1. Truth Tables
2. Argument Validity
3. Truth Sets
4. Negations
5. Direct Proof
6. Division into Cases Proof
7. Contradiction Proof
8. Contrapositive Proof

Date	Topic	Section	Study
3/13	Proof review		handout
3/15	Sequences	5.1	p.273 #1-4,19-24,43-46,63-66
3/17	Induction	5.2	p.286 #3-4,12-18,21-23
3/20	Induction Apps	5.3	p.297 1,8-12,16-18 **Portfolio due**
3/22	Induction review	5.3	p.297 24-26 **QUIZ #4**
3/24	Recursive Sequences	5.6	p.337 #3-4,22-27,37-39
3/27	Solving Recursive	5.7	p.350 #5-12,19-20,23-26
3/29	Set Theory	6.1	p.388 #3-6,9,11-12,21-24,31-32
3/31	Properties	6.2	p.404 #1-2,7-10,16-20,33-35
4/3	Disproofs	6.3	p.412 #5-12,22
4/5	Algebraic Proofs	6.3	p.412 #31-35 **QUIZ #5**
4/10	Functions	7.1	p.436 #3,6-8,13-14,17-18,29,41-44
4/12	Properties	7.2	p.457 #5-6,9-11,15-18,20-22
4/14	Cardinality	7.4	p.485 #3-5,10-12,17-21
4/17	Graphs	10.1	p.694 #8-18,22,29-35
4/19	Trees	10.4	p.731 #3,10-18
4/21	Trees	10.4	p.731 #22-23 **QUIZ #6**
4/24	Big-O	11.2	
4/25	Review		
5/1	Final Exam 2-5		**Portfolio due**

Final Portfolio Topics

1. Induction Proofs
2. Defining Recurrence Relations
3. Solving Recurrence Relations
4. Proving Explicit Formulas
5. Set Theory Definitions
6. Subset Proofs
7. Empty Set Proofs
8. Set Disproof
9. Function Definitions
10. One-one Proofs
11. Onto Proofs
12. Graph Theory Definitions
13. Graph Theory Proofs

Model Reflection Paper

(This is made up, but shows what I'd like to get from you. The two main elements are (1) brief summary of talk and (2) some original thought on the subject.)

The talk on September 7th was by Dr. Sue Dokoo of Pseudo Duke University. Her research is in the game of Sudoku and discussed different aspects of this game. I have seen other people playing it, but did not know the rules or any of the mathematics behind it.

In this game, a 9x9 playing space is provided. An example given was:

		6	2			5	8	
4		2	5					7
				7	8	6		3
5		1		6	7			8
	3						6	
6			8	2		9		1
7		4	3	9				
9					5	2		6
	5	3			1	4		

To "solve" the puzzle, one could just enter numbers in a brute-force kind of way to see if they could get a working configuration. However, sitting in a room full of mathematicians, taking a more analytical approach seemed to be the dominant strategy. Treating this as a constraint-satisfaction problem, you can identify that certain cells must contain specific values. This leads to the conclusion that there is exactly one solution to a "well-formed" Sudoku.

This got me thinking about well-formed Sudoku, and how they are generated in the first place. It seems unlikely that the seeds are randomly assigned, you run the risk of violating set-up rules. A bigger problem is that the seeds may not constrain the possibilities enough to make a unique solution. Another naïve approach might be to take a completed grid and start taking away numbers, but I suspect that you might have a similar issue in terms of necessary constraints.

One that I want to think about is: In forming a viable Sudoku, is it the number of seeds or the placement of seeds that is more critical? I suspect the latter. Also,

- What is the maximum number of seed numbers that can be provided and still result in an ambiguous (unsolvable) puzzle?
- What is the minimum number of seed numbers that can be provided to generate a (uniquely) solvable puzzle?

We were provided two puzzles – one was rated "Easy" the other "Difficult".

- What goes into the rating system?
- Does a difficult puzzle necessarily have fewer seed numbers?
- Is the rating of the complexity somehow determined by the deductive skills required?

Math 131 Information Sheet

Name:

Intended Major:

Hometown:

List any other college math courses you have taken.

Why do you think that theoretical mathematics is important?

What campus activities do you expect to be involved in this semester?