



Discrete Structures

CSCI 246

Instructor Info —



Dr. Michael Wojnowicz (Mike)



Office Hrs: Mon & Wed 1-1:45p,
Wed 3:15-4:45p



Barnard 352



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Course Info —



Prereq: Calculus, although this is not used.



Class meetings: Mon, Wed, Fri
2:10-3p



Reid 401

TA Info —



Fatima Ododo



Mon, Thurs 10-11am



Student Success Center
(Barnard 259)



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Tutor Info —



Kelly Joyce



kelly.joyce1@student.montana.edu



Sun 3-5pm



SmartyCats Center (2nd floor
Renne)

Course description

Mathematical concepts used in computer science with an emphasis on mathematical reasoning and proof techniques. This course covers mathematical thinking (elementary logic, theorems, proof techniques), discrete collections (such as sets and lists), functions and relations, counting (including permutations and combinations), and miscellaneous topics (recursions, Big-O notation, graphs). Writing and understanding proofs will be an important part of this course.

Textbooks

Primary text

Scheinerman, E. R. (2013). *Mathematics: a discrete introduction*. Third edition.

Supplemental text

Hamkins, J. D. (2020). *Proof and the Art of Mathematics*. MIT Press.

Learning Outcomes

- To understand several central concepts from discrete mathematics that are used throughout computer science;
- To learn to reason mathematically and communicate ideas in a clear and concise manner;
- To use induction and other techniques of mathematical proofs.

Learning Philosophy

This course will use an "inquiry-based learning" approach. This means that classes will not be lecture-oriented. Instead, to quote Dr. Dana Ernst,

You will be expected to work actively to construct your own understanding of the topics at hand with the readily available help of me and your classmates. Many of the concepts you learn and problems you work on will be new to you and ask you to stretch your thinking. You will experience frustration and failure before you experience understanding. This is part of the normal learning process. If you are doing things well, you should be confused at different points in the semester.

Active learning has been shown to increase student performance in STEM courses (e.g. see [1, 2]).

Class activity

A typical class meeting will be structured as follows:

Mon/Wed

- Reading quiz: 5 mins.
- Mini-lecture: 15 mins
- Group exercises: 30 mins

Fri

- Reading quiz: 5 mins
- Problems quiz: 10 mins
- Mini-lecture: 5-10 mins
- Group exercises: 25-30 mins

Group exercises

The group exercises are for collaborative problem-solving. Students will be split randomly into groups of three to work on problems using the whiteboards (or windows). Mathematics is not a spectator sport!

Daily readings

Before each class meeting, you will be assigned a reading from the textbook. The reading serves preparation for the group exercises. Before each class, submit your answers to a short reader response questionnaire (with questions like, "what did you find confusing?") posted as a survey Brightspace. Each class meeting will begin with a 5-minute reading quiz.

Weekly review quiz

The problems quiz will be based on the problems given in-class.

FAQs

? What are discrete structures?

! A discrete structure refers to a mathematical system that is composed of distinct, separate elements, as opposed to continuous structures where elements can vary smoothly. Think of a digital clock vs. an analog clock (where second hand loops around continuously without stopping). Examples of discrete structures include sets with finitely many elements (e.g. the integers 1 to 10), lists, graphs, and logical statements.

? What is discrete mathematics?

! Discrete mathematics is the study of discrete structures and mathematical operations that can be performed upon them.

? Why study discrete mathematics?

! It is the mathematics underlying almost all of computer science. Here are a few examples: (1) designing high-speed networks and message routing paths, (2) finding good algorithms for sorting, (3) performing web searches, (4) analyzing algorithms for correctness and efficiency, (5) formalizing security requirements, and (6) designing cryptographic protocols.

? Where is discrete mathematics used in the MSU computer science curriculum?

! Discrete mathematics is used throughout the curriculum. Proofs in particular play a critical role in CSCI 338 (Computer Science Theory) and CSCI 432 (Advanced Algorithm Topics).

Grading

- Reading Quizzes (Daily): 25%
- Problems Quizzes (Weekly): 20%
- Project: 15%
- Participation: 15%
- Final: 25%

Grades will be assigned as follows:

A: 90-100, B+: 87-90, B: 80-87, C+: 77-80, C: 70-77, D+: 67-70, D: 60-67

Project

The purpose of the project is for students to focus on some aspect of discrete mathematics of particular interest. Students will work in small groups, choose some aspect of discrete mathematics (that was not covered in class), and develop a 5 minute presentation to give to the class. For example, a group might give an overview to public key cryptography, or explore how graph theory underlies web search. More information will be given as the time approaches.

Makeup policy

Quizzes and participation have no makeups. However, I drop 3 reading quizzes, 3 participation days, and 1 problems quiz with no consequence. Missed material beyond that (with a valid explanation) can be replaced with the final exam grade.

Communication expectations

For non-personal questions related to course content, please use the Ask Your Instructor form on D2L, so that all students can benefit from the question and answer. For personal questions, please contact me by e-mail.

Diversity and Inclusivity Statement

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability - and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. Your suggestions about how to improve the value of diversity in this course are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups.

Accommodations for Students with Disabilities

If you are a student with a disability and wish to use your approved accommodations for this course, contact me during my office hours to discuss. Please have your Accommodation Notification available for verification of accommodations. Accommodations are approved through the Office of Disability Services located in 137 Romney Hall. www.montana.edu/disabilityservices.

Student Conduct

You are expected to abide by MSU's Code of Student Conduct.

Class Schedule

MODULE 0: Course Overview

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|-----|--------|-----------------|
| Wed | Jan 15 | Course Overview |
|-----|--------|-----------------|

MODULE 1: Introduction to mathematical thinking

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|-----|--------|------------------------------|----------|
| Fri | Jan 17 | Theorem | Sec 4 |
| Mon | Jan 20 | Holiday (Martin L. King Day) | |
| Wed | Jan 22 | Proof | Sec 5 |
| Fri | Jan 24 | Counterexample | Sec 6 |
| Mon | Jan 27 | Boolean Algebra | Sec 7 |
| Wed | Jan 29 | Multiple Proofs | JDH CH 2 |
| Fri | Jan 31 | Induction | JDH CH 4 |
| Mon | Feb 3 | Induction (continued) | JDH CH 4 |

MODULE 2: Discrete Collections

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|-----|--------|--------------------|--------|
| Wed | Feb 5 | Lists | Sec 8 |
| Fri | Feb 7 | Factorial | Sec 9 |
| Mon | Feb 10 | Sets | Sec 10 |
| Wed | Feb 12 | Quantifiers | Sec 11 |
| Fri | Feb 14 | Operations on Sets | Sec 12 |

MODULE 3: Functions and relations

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|-----|--------|-------------------------------------|-----------|
| Mon | Feb 17 | Holiday (President's Day) | |
| Wed | Feb 19 | Functions and Relations | JDH CH 11 |
| Fri | Feb 21 | Functions and Relations (continued) | JDH CH 11 |
| Mon | Feb 24 | Relations | Sec 14 |
| Wed | Feb 26 | Equivalence Relations | Sec 15 |
| Fri | Feb 28 | Functions | Sec 24 |

MODULE 4: Counting

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|-----|--------|-------------------------------|-------------|
| Mon | Mar 3 | Permutations and Combinations | JDH Sec 5.6 |
| Wed | Mar 5 | Partitions | Sec 16 |
| Fri | Mar 7 | Binomial Coefficients | Sec 17 |
| Mon | Mar 10 | Inclusion-Exclusion | Sec 19 |

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|-----|--------|----------------------|--------------------------------|
| Wed | Mar 12 | Pigeonhole Principle | Sec 25 (Optional: JDH Sec 5.7) |
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MODULE 5: Discrete probability

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|------|-----------|---------------------------------------|--------|
| Fri | Mar 14 | Sample Space | Sec 30 |
| Week | Mar 17-21 | Spring Break | |
| Mon | Mar 24 | Events | Sec 31 |
| Wed | Mar 26 | Conditional Probability /Independence | Sec 32 |
| Fri | Mar 28 | Random variables | Sec 33 |
| Mon | Mar 31 | Expectation | Sec 34 |

MODULE 6: Recurrence, complexity, and graphs

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|-----|-------|--------------------------|-------------------------------------|
| Wed | Apr 2 | Recurrence | Sec 23 |
| Fri | Apr 4 | Complexity | Handout to be posted on Brightspace |
| Mon | Apr 7 | Graph theory | JDH CH 12 |
| Wed | Apr 9 | Graph theory (continued) | JDH CH 12 |

MODULE 7: Group Presentations

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|-----|--------|--|
| Fri | Apr 11 | Prepare Group Presentation |
| Mon | Apr 14 | Prepare Group Presentations |
| Wed | Apr 16 | Group Presentations |
| Fri | Apr 18 | Holiday (University Day / Mike's Birthday) |
| Mon | Apr 21 | Group Presentations |
| Wed | Apr 23 | Group Presentations |
| Fri | Apr 25 | Final Preparation |

Note: The class schedule is tentative; it is subject to change as the course progresses.

External Resources

For a list of external resources on discrete mathematics, click [here](#). This list will be updated throughout the semester.

* References

- [1] Louis Deslauriers, Ellen Schelew, and Carl Wieman. Improved learning in a large-enrollment physics class. *science*, 332(6031):862–864, 2011.
- [2] Scott Freeman, Sarah L Eddy, Miles McDonough, Michelle K Smith, Nnadozie Okoroafor, Hannah Jordt, and Mary Pat Wenderoth. Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the national academy of sciences*, 111(23):8410–8415, 2014.