MAT230 Discrete Mathematics

Fall 2019

General Information

Meeting Time and Place

Monday, Wednesday, and Friday: 11:25 a.m. – 12:25 p.m., KOSC 125.

Professor

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Office Hours

Monday, Wednesday: 3:20 – 4:20 p.m.,
Tuesday: 1:30 – 3:00 p.m., Thursday: 10:00 – 11:30 a.m.,
and by appointment.

Texts

(Required) *An Active Introduction to Discrete Mathematics and Algorithms*, Version 2.6.3, GNU License, 2018. https://cusack.hope.edu/Notes/Notes/Books/Active Introduction to Discrete Mathematics and Algorithms/ActiveIntroToDiscreteMathAndAlgorithms.2.6.3.pdf

(Supplementary) *Book of Proof*, Third Edition by Richard Hammack, 2018.
http://www.people.vcu.edu/~rhammack/BookOfProof/index.html
No reading or work will be assigned from this text, but you might find it helpful to read sections of it if you'd like a slightly different perspective on a topic than that offered by our main text. It's quite readable (for a math book).

Prerequisite

College Algebra. Introductory programming experience (e.g. CPS121) will be helpful as you will need to read and write pseudocode.

Online Materials

A copy of the course syllabus, homework assignments, and classroom presentation notes can be found on the Blackboard server *http://blackboard.gordon.edu* and on the departmental web server at *http://www.math-cs.gordon.edu/courses/mat230*.

Academic Accommodations

Our academic community is committed to providing access to a Gordon education for students with disabilities. A student with a disability who intends to request academic accommodations should follow this procedure:

1. Meet with a staff person from the Academic Success Center (ASC) and provide them

with current documentation of the disability;

2. Obtain a Faculty Notification Form from the ASC, listing appropriate accommodations; and
3. Submit this form to professors and discuss those accommodations with them, ideally within the first two weeks of classes.

Some accommodations need more time to arrange so communicating early in the semester is important. For more information consult http://www.gordon.edu/academicaccessibility or email *asc@gordon.edu*.

Academic Dishonesty

Academic dishonesty is regarded as a major violation of both the academic and spiritual principles of this community and may result in a failing grade or suspension. Academic dishonesty includes plagiarism, (see Plagiarism in Student Handbook), cheating (whether in or out of the classroom), and abuse or misuse of library materials when such abuse or misuse can be related to course requirements.

Course Description

Introduction

While many beginning mathematics and computer science students equate *computer science* with *programming*, the actual act of programming is a relatively small part of the discipline of computer science. Many concepts central to computer science have their basis in mathematical reason.

This course is designed to introduce a range of mathematical topics that are important to the computer scientist, such as basic logic and proof techniques, set theory, functions, induction, number theory, combinatorics, discrete probability, relations and equivalence relations, graphs, and trees. Although the topics may often seem unrelated, two common threads run throughout the course; the notions of proof and mathematical rigor. Consequently, the *methods of the course are of major importance*. Not only is it important that you master the basic material we will study, it is also important that you begin to think mathematically and that you feel comfortable with mathematical processes and procedures.

The notion of *proof* plays a central role in this class. While obviously important to the mathematician, it may be less obvious exactly why this is important for the computer scientist. In fact, a proof is a carefully devised and presented argument that justifies the truth of a particular statement. In this sense demonstrating that a particular algorithm will always perform as expected is a proof. Even more fundamentally, ensuring a complicated *if-then-else* structure works as desired requires exactly the reasoning that is developed by studying mathematical proofs. In some sense writing a good proof and writing a good program are quite similar activities, using many of the same steps.

Content and Learning Objectives

This course covers basic logic, proof techniques, set theory, functions, relations, mathematical

induction, counting (including combinations and permutations), graphs, and basic probability.

Students completing this course will:

- be able to analyze and understand logic statements.
- learn about and be able to use basic proof techniques.
- Know and work with some of the basic tools of mathematics: set theory, relations, functions, combinatorics, and basic probability.

Procedure and Workload Expectation

Class time will be based on reading assigned for that day. Note that our text requires you to complete statements and/or problems as part of the reading; you should come to class with these completed to the best of your ability. We will cover main concepts from the day's topic in class and spend time going over questions. It is my hope that many days we can get a head-start on the homework assignment before leaving class. Homework will be collected on most days. It will be graded and returned to you.

For each semester hour of credit, students should expect to spend a minimum of 2–3 hours per week outside of class in engaged academic time. This time includes reading, writing, studying, completing assignments, lab work, or group projects, among other activities.

Course Requirements

Attendance, Participation, and Classroom Expectations

You are expected to attend class. I will call roll for the first several days of the course and will continue to mark attendance for the remainder of the term. In the event that your grade is on the borderline at the end of the term it will be to your advantage to have few or no absences. Please let me know ahead of time if you know you will miss a class, come late, or leave early. Also, please refrain from leaving and re-entering the classroom while class is in session.

Note that 5% of your final grade is based on your participation in class. This means that you are present and engaged in all classroom activities.

Laptops and tablets may be used only when appropriate for the current classroom activity. You may not use a mobile phone or other device for texting or otherwise communicating with others during class. This activity prevents you from fully concentrating on our topic and is distracting to those around you and to the professor.

Homework Assignments

Homework will be due at the start of each class period. Only in unusual circumstances will an assignment be accepted late without penalty. The following are required of all assignments:

- Assignments are to be done on 8.5×11 paper and must not have ragged edges from spiral bound notebooks.
- Solutions should be laid out in an organized manner.
- Multiple page assignments must be fastened together.

- Most importantly: your work must be legible; if it's too difficult to read then it will not be graded, but you *may* be given the opportunity to redo the assignment.

You are permitted to work together on the homework assignments. However, the work you turn in should be your own. These problems should be considered tools to help you better understand the theory and to become more proficient with the techniques of this course. It is essential that you understand the solution to each problem in order to derive the greatest benefit from this course. This is particularly important when it comes to making a mathematical argument and writing proofs.

Examinations

There will be three exams: two in-class exams and a comprehensive final exam at the end of the term.

Grading Procedure

Your final average will be computed using the following table:

Component	***Percentage***
Homework	35%
Exam 1	20%
Exam 2	20%
Final	20%
Participation	5%

The following table shows the correspondence between the final average and the letter grades that will be assigned.

[100 – 97]	A+	(90 – 87]	B+	(80 – 77]	C+	(70 – 67]	D+
(97 – 94]	A	(87 – 84]	B	(77 – 74]	C	(67 – 64]	D
(94 – 90]	A–	(84 – 80]	B–	(74 – 70]	C–	(64 – 60]	D–

Tentative Schedule

Day	**Date**	**Read & Work**	**Topic & Assigned Problems**
Wednesday	8/28	Pp. vii–viii	*Introduction and motivating problems*
Friday	8/30	2.1–2.2	*Direct proofs; Implication and its friends*
Monday	9/2	No class	*Labor Day*
Wednesday	9/4	2.3–2.4	*Proofs by contradiction and contraposition* # 2.1, 2.2, 2.5, 2.6a
Friday	9/6	2.5–2.6	*Other proof techniques & If-and-only-if Proofs* # 2.6b, 2.7, 2.13, 2.16, 2.17, 2.18, 2.19 (extra credit)
Monday	9/9	2.7–2.8	*Common errors in proofs & more practice* # 2.8–2.12
Wednesday	9/11	3.1–3.3	*Algorithms; The mod operator and integer division; If-then-else* (no problems assigned)
Friday	9/13	3.4–3.6	*The* `for` *loop, arrays, and the* `while` *loop* # 3.1, 3.2, 3.7(a,b)
Monday	9/16	4.1	*Propositional logic* # 3.4, 3.5, 3.12
Wednesday	9/18	4.2	*Propositional equivalence* # 3.14, 4.1
Friday	9/20	4.3–4.5	*Predicates and quantifiers; Normal forms; Bitwise operations* # 4.2, 4.5, 4.6, 4.15, 4.18
Monday	9/23	5.1	*Sets* # 4.9(a,c,e), 4.10
Wednesday	9/25	5.2	*Set operations* # 4.12(a,i,l)
Friday	9/27	5.3	*Functions* # 5.2(e), 5.4
Monday	9/30	5.4	*Partitions and equivalence relations* # 5.7, 5.8 (one sentence will suffice), 5.13

Day	**Date**	**Read & Work**	**Topic & Assigned Problems**
Wednesday	10/2	6.1	*Sequences* # 5.14, 5.15, 5.19
Friday	10/4	**Exam 1**	*Chapters 2–5*
Monday	10/7	6.2	*Sums and products* # 6.5
Wednesday	10/9	7.1.1–7.1.2	*Asymptotic notation: varieties and properties* # 6.7
Friday	10/11	7.1.3	*Proofs using the definitions* # 7.1, 7.2
Monday	10/14	7.1.4	*Proofs using limits* # 7.4(a)
Wednesday	10/16	7.2	*Common growth rates* # 7.4(b), 7.6
Friday	10/18	No class	*Quad Finals*
Monday	10/21	7.3.1–7.3.3	*Analyzing algorithms; Common complexities; Sorting* # 7.3, 7.7
Wednesday	10/23	8.1.1–8.1.2	*Mathematical Induction: basics, equalities & inequalities* # 7.10(a–k), 7.11
Friday	10/25	8.1.3–8.1.4	*Variants of induction including Strong induction* # 8.1, 8.2
Monday	10/28	8.1.5–8.1.6	*Common induction errors; Summary and tips* # 8.3, 8.4
Wednesday	10/30	8.2	*Recursion* Supplementary Induction Problems
Friday	11/1	8.3.1–8.3.2	*Solving Recurrence relations: substitution and iteration* # 8.6
Monday	11/4	8.3.3–8.3.4	*The Master Theorem; Linear recurrence relations* # 8.8(a): Solve using iteration and use induction to prove your result is correct
Wednesday	11/6	8.4	*Analyzing recursive algorithms* # 8.10(b,c,f), 8.13

Day	**Date**	**Read & Work**	**Topic & Assigned Problems**
Friday	11/8	9.1–9.2	*Counting: Multiplication and sum rules; pigeonhole principle* # 9.1, 9.3
Monday	11/11	9.3	*Permutations and combinations* # 9.5, 9.7
Wednesday	11/13	**Exam 2**	*Chapters 6–8*
Friday	11/15	9.4–9.5	*Binomial Theorem and Inclusion-Exclusion principle* # 9.9, 9.11
Monday	11/18	Notes	*Discrete probability* # 9.18(a,e,h), 9.25
Wednesday	11/20	Notes	*Sum and product rules* Homework on Discrete Probability
Friday	11/22	Notes	*Probability in games of chance* Homework on Sum and Product Rules for Probability
Monday	11/25	Notes	*Applications of probability theory* Homework on Probability in Games of Chance
Wednesday-Friday	11/27-12/1	No Class	*Thanksgiving Recess*
Monday	12/2	10.1–10.4	*Types of graphs; Graph terminology; Special graphs; Handshaking lemma* Homework on Expected Value
Wednesday	12/4	10.5–10.7	*Graph representations; Problem solving with graphs; Traversability* # 10.1, 10.2, 10.3, 10.4
Friday	12/6	10.8, Notes	*Planarity* Homework on Graphs (part 1)
Monday	12/9	Notes	*Trees* Homework on Graphs (part 2)
Wednesday	12/11		*Review* Homework on Trees
Monday	**12/16**		**Final Exam:** 9:00 – 11:00 a.m.