MATH 3315: Discrete Mathematics and Combinatorics

Term: Spring 2023
Time and Place: TR 4:00pm – 5:15pm in SCI 2.235
Instructor: Nathan Williams
Office: FO 2.402C
Office hours: TR 2:30pm – 3:30pm, or by appointment
E-mail: Nathan.Williams1@utdallas.edu

Textbook: Kenneth Rosen, *Discrete Mathematics and its Applications*, eighth edition, McGraw-Hill (2019)

Pre-requisites: Math 2417 (or equivalent) or instructor consent.

Course description: This course covers basic tools of enumerative combinatorics, equivalence relations, combinatorial proofs and recurrences, inclusion-exclusion, generating functions, and graphs and trees.

Learning Outcomes:

1. Students will become familiar with fundamental objects and techniques in discrete mathematics.
2. Students will build a firm foundation in discrete mathematics to aid in their future studies. They will be able to identify which tools are relevant and applicable for a given situation or problem.
3. Students will be able to apply the core concepts to solve mathematical and computational problems.

Instructional Mode: Traditional, subject to university guidance. Please visit https://www.utdallas.edu/covid/students-families-info/ for further details.

Expectations: Besides attending lectures, students should regularly and actively participate in the course by giving feedback and asking questions during class, office hours, email, or message boards.

Homework: Homework assignments will be posted on eLearning. Every assignment should be completed independently by each student; however, students are encouraged to collaborate in thinking through the homework assignments, so long as they provide the names of their collaborators. Homework will account for 25% of the course grade.

Exams: There will be two midterms and a final exam. All exams are closed-book and closed-notes.

Grading: Students must show all details of their work to receive full credit.

- Homework: 25%
- Two Exams (Exam I & Exam II): 25% each
- Final: 25%

Important dates:

Monday, August 21: Classes begin
Monday, September 4: University closed; Labor Day
Monday, November 20 – Sunday, November 26: University closed; Fall Break and Thanksgiving holidays
Thursday, December 7: Classes end

Comet Creed This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

"As a Comet, I pledge honesty, integrity, and service in all that I do"

Academic Support Resources The information contained in the following link lists the Universitys academic support resources for all students. Please go to Academic Support Resources webpage for these policies.

UT Dallas Syllabus Policies and Procedures The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus. Please go to UT Dallas Syllabus Policies webpage for these policies.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.

Academic Calendar

Tuesday	Thursday
Aug 22nd **1** **1.7.** Foundations, introduction to proofs.	24th **2** **1.8.** More introduction to proof.
29th **3** **2.1-2.4.** Sets and set operations; functions, bijections. **Homework 1 due.**	31st **4** **2.5.** More sets. Injective and surjective functions. Countable and uncountable sets.
Sep 5th **5** **2.5.** Boolean functions and Cantor's diagonalization. **Homework 2 due.**	7th **6** **2.5, 9.5, 9.6.** Cantor-Bernstein; equivalence relations and set partitions.
12th **7** **9.6.** Equivalence relations and set partitions. **Homework 3 due.**	14th **8** **3.1.** Algorithms, partial orders, and lattices.
19th **9** **Midterm I.** **Homework 4 due.**	21st **10** **4.3.** The Euclidean algorithm and Bézout's theorem.
26th **11** **3.1–3.3.** Linear and binary search. Growth of functions and complexity of algorithms.	28th **12** **3.1–3.3.** Growth of functions and complexity of algorithms.
Oct 3rd **13** **3.1–3.3.** Bubble sort and merge sort. The halting problem. **Homework 5 due.**	5th **14** **4.1.** Modular arithmetic.
10th **15** **4.2.** Divisibility tests. Binary and other bases. Fermat's little theorem. **Homework 6 due.**	12th **16** **4.2.** Applications of other bases: Nim, the Cantor set, and another game.
17th **17** **4.4.** The chicken nugget problem and the Chinese remainder theorem. **Homework 7 due.**	19th **18** **5.1-5.3.** Induction and recursively-defined functions. Binomial coefficients.
24th **19** **Midterm II.** **Homework 8 due.**	26th **20** **6.3,6.4, 8.1.** Factorials and permutations, binomial coefficients and subsets. Combinatorial proofs.
31st **21** **6.1, 6.2, 6.3, 6.4.** Counting, choosing with replacement. Permutations and combinations. **Homework 9 due.**	Nov 2nd **22** **8.4.** Generating functions and Fibonacci numbers.
7th **23** **8.4.** Euler's Pentagonal Number Theorem. **Homework 10 due.**	9th **24** **8.4.** Recurrence relations and Catalan Numbers.
14th **25** **8.5, 8.6.** Inclusion-exclusion. Derangements. Solving integer equations with constraints. **Homework 11 due.**	16th **26** **8.5, 8.6.** More inclusion-exclusion.
21st **27** **Fall Break**	23rd **28** **Fall Break**
28th **29** **10.1, 10.2** Introduction to Graph Theory	30th **30** **10.5** De Bruijn Graphs and Eulerian circuits.
Dec 5th **31** **11.1–11.3** Trees, Prüfer codes and labeled trees; tree traversals. **Homework 12 due.**	7th **32** **11.5.** Prim, Dijkstra, and Kruskal.