MATH 6312: Combinatorics and Graph Theory

Term: Spring 2026
Time and Place: Mondays & Wednesdays, 1:00pm – 2:15pm in GR 4.301
Instructor: Theo Douvropoulos – theodosios.douvropoulos@utdallas.edu
Office: FN 3.120L
Office hours: Wednesdays 4pm – 6pm, or by appointment.
Grader: TBD

Textbook: Instructor Notes.

Additional Resources:

- Stanley, R. P. (2012). Enumerative combinatorics Volume 1 (2nd ed.). *Cambridge University Press.* Available online at UTD Library.
- Stanley, R. P. (2024). Enumerative combinatorics Volume 2 (2nd ed.). *Cambridge University Press.* Available online at UTD Library.
- Stanley, R. P. (2013). Algebraic combinatorics: walks trees tableaux and more. *Springer & SpringerLink.* Available online at UTD Library.
- Loehr, N. A. (2018) Combinatorics (2nd ed.). *CRC Press, Taylor & Francis Group.* Available online at UTD Library.
- Harris, J. M., Hirst, J. L., Mossinghoff, M. J. (2008). Combinatorics and graph theory (2nd ed.). *Springer & SpringerLink.* Available online at UTD library.
- Ardila, F. (2015), Algebraic and geometric methods in enumerative combinatorics. Available online at https://arxiv.org/abs/1409.2562.
- Martin, J. (2010-2025) Lecture notes on Algebraic Combinatorics. Available online at https://jeremymartinmath.github.io/CombinatoricsNotes.pdf.

Pre-requisites: Both Theoretical Concepts of Calculus and Abstract Algebra I, or instructor consent.

Course description: This course covers theory and applications of combinatorics and graphs, topics from basic counting principles, principle of inclusion and exclusion, permutation statistics, ordinary and exponential generating functions, composition of integers, integer partitions, Stirling numbers of the first kind, q-analogs of binomial and multinomial coefficients, Euler's formula, Hamilton paths, planar graphs, chromatic and Tutte polynomials, and algorithms on networks.

Student Learning Objectives and Outcomes

1. Students will be able to articulate basic definitions and theorems in enumerative combinatorics and graph theory.
2. Students will be able to apply definitions/theorems to solve problems involving application of counting principles in many counting situations.
3. Students will be able to apply graph theoretical techniques and algorithms for solving typical graph problems.

Expectations: It is a basic expectation of all students that they will attend all lectures, and that they will regularly and actively participate in the course by asking and responding to questions during class, office hours, and/or email.

Homework: Homework assignments will be posted on eLearning and GradeScope and are due every Friday on GradeScope. Every assignment should be completed independently by each student; however, students are encouraged to collaborate in thinking through the homework assignments.Late homeworks will not be accepted, except in case of extenuating circumstances that are communicated promptly to the instructor.

CoCalc HW: There will be digital HW on CoCalc every 2-3 weeks. Students will be asked to program basic functions using the library SageMath. Grading will be done through CoCalc.

Participation: There will be reading assignments before each class meeting. Students will be asked to write a brief (2-3 paragraphs) summary with questions. This will be done through GradeScope and together with attendence will constitute 5% of the course grade.

Exams: There will be three exams. Each exam will account for 20% of the course grade. All exams are closed-book and closed-notes.

Grade Components: Note that students must show all details of their work to receive full credit.

- Written Homework: 30%
- CoCalc HW: 5%
- Participation: 5%
- Exam I: 20%
- Exam II: 20%
- Exam III: 20%

Grading Scale:

	$[90-100] \to A$	$[85-90) \to A-$
$[80-85) \to B+$	$[75-80) \to B$	$[70-75) \to B-$
$[65-70) \to C+$	$[60-65) \to C$	$[55-60) \to C-$
$[0-55) \to F$		

Important dates:

Tuesday, January 20: Classes begin
Wednesday, February 4: Census Day (last day to drop without a W)
Monday, February 23: Exam I
Monday, March 16 – Sunday, March 22: No classes; Spring Break
Monday, April 6: Exam II
Wednesday, April 8: Withdrawal period ends
Wednesday, May 6: Final Exam
Friday, May 8: Last day of classes

Tentative Schedule of Topics:

Monday	Wednesday
Jan 19th University closed: Martin Luther King Jr. Day	21st **1** Undergrad review: (multi)-selections, binomial theorems, Eulerian numbers
26th **2** The twelve-fold way in counting; Stirling numbers	28th **3** q-counting and permutation statistics
Feb 2nd **4** Inclusion-Exclusions; Posets; Möbius functions	4th **5** Sperner property; Chain Decompositions
9th **6** Generating Functions: Recursions, Integer partitions	11th **7** Generating Functions: Exponential formula, Lagrange Inversion
16th **8** Bijective proofs	18th **9** Catalan objects
23rd Exam I: in-class	25th **10** Graph Fundamentals
Mar 2nd **11** Trees; spanning trees; graph searching	4th **12** Euler Tours, Hamiltonian Cycles, and Traversal Structure
9th **13** Planarity I: Planar Embeddings, Euler's Formula, and Kuratowski	11th **14** Planarity II: Dual Graphs, Duality, and Applications
16th No classes: Spring Break	18th No classes: Spring Break
23rd **15** Matrix–Tree Theorem; enumerating Spanning Trees	25th **16** Colorings and the Chromatic Polynomial
30th **17** Flows, Cuts, and Network Optimization	Apr 1st **18** Ramsey Theory
6th Exam II: in-class	8th **19** Simplicial Complexes and Face Enumeration
13th **20** Hyperplane Arrangements: characteristic polynomials	15th **21** Hyperplane Arrangements: combinatorial models for regions
20th **22** Ehrhart theory	22nd **23** Combinatorial reciprocity theorems
27th **24** Symmetric functions: ring structure and bases	29th **25** Symmetric functions: Irreducible S_n representations, Young tableaux
May 4th **26** Symmetric functions: RSK	6th Final Exam: in-class

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 University's academic support resources for all students are detailed in the following link: Academic Support Resources.

UT Dallas Syllabus Policies and Procedures: The University's policies and procedures concerning course syllabi are available at the following link: UT Dallas Syllabus Policies.

The descriptions and timelines contained in this syllabus are subject to change at the Instructor's discretion.