Math 621: Combinatorial Commutative Algebra
Spring 2022

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Course Content: Combinatorial and computational aspects of commutative and homological algebra, including graded rings and algebras, Hilbert series, graded free resolutions, and Gröbner bases. Applications to lattice point geometry and polyhedral combinatorics. Additional topics as time permits.

Texts: Content will be sampled from the following textbooks. All are optional, but will be useful references.

- *Combinatorial Commutative Algebra*, by Ezra Miller and Bernd Sturmfels.
- *Combinatorics and Commutative Algebra*, by Richard Stanley.
- *Computing the Continuous Discretely*, by Matthias Beck and Sinai Robins.

Prerequisites: Math 620 with a grade of C or better.

Course Organization: The class will be organized as follows.

- One class day each week (usually Tuesday), I will give a lecture on course material.
- The other class day each week will be a "problem session" wherein you work in small groups on problems designed to lead you to discover some of the course content (in particular, these problems **introduce new material**).

A problem list will be distributed at the beginning of each problem session, containing the in-class problems as well as the weekly homework problems. The in-class problems will not be turned in, but the content they introduce will be vital to the course. All completed homework problems will be turned in for credit, usually the following Thursday.

Before each problem session, a short list of "preliminary problems" will be assigned, and should be completed before the problem session. These assignments will be short, usually requiring at most 10 minutes to complete, and will be computational in nature (i.e. no proofs).

Although I intend to use this format throughout the course, I reserve the right to restructure the course as the term progresses, based in part on student feedback and performance. I will periodically collect anonymous feedback in class, but feel free to come talk to me if you have suggestions or concerns.

Grading Policy: Your grade will be determined by weekly homework sets, a participation grade, and a project, weighted as follows.

Homework	60%	A = 90-100
Project	30%	B = 80-89
Participation	10%	C = 70-79
Total	100%	D = 60-69
		F = 0-59

Although there is no final exam, the final exam date, scheduled for Thursday, May 12th from 3:30pm-5:30pm, will be utilized for project presentations. Keep this date in mind when making travel plans for the end of the term.

Participation: Attendance in problem sessions is vital to success in this class, since **new material** will be covered. Your participation grade will be based on the following:

- attending and participating in lectures;
- attending and engaging in problem sessions; and
- completing all preliminary problem.

Missing class will result in a lowered participation grade, and only university excused absences with **advance notice** to the instructor will be accepted. I reserve the right to deduct one **additional full letter grade** from your course grade if you miss too many classes, or if sufficient participation is not demonstrated during problem sessions.

Homework: There will be one homework assignment given each week, as well as a short list of preliminary problems to be completed before each problem session. Completed homework assignments **must be typeset in LaTeX** and will be submitted to the instructor for a grade; preliminary problems will not be collected. Collaboration is encouraged, but solutions must be written individually, and **collaborators must be identified** on the front of your assignment.

Homework assignments, along with their due dates, will be posted on the course webpage as they are assigned. Out of fairness to the other students, late homework assignments will not be accepted for credit. However, the lowest homework grade of the term will be dropped.

Project: Each student will complete an independent project. Topics can be selected from a list provided by the instructor, or chosen independently, but must be approved either way. The project grade will be determined by

- regular progress in meetings with the instructor,
- a final writeup due on the final exam day, and
- a final presentation during the final exam time.

Class Announcements, E-mail Policy and Communications: Class announcements will be posted to my class web page and sent to your university e-mail account. Be sure to regularly check your e-mail. If you send me an e-mail, please include your name and course information (i.e. class and section) as well as any additional information that I might need to respond to your e-mail.

Attendance, Absence, and Makeup Work Policies:

- Attendance is **essential** for success in the course, especially problem session days!
- Late homework will not be accepted. However, your lowest homework grade will be dropped.
- The last day to drop this class is **February 1st**.

Student Learning Outcomes:

- Students will be able to write clear, correct proofs of mathematical statements involving algebraic, combinatorial, and discrete geometric objects.
- Students will be able to use algebraic, combinatorial, and geometric methods to compute and interpret graded algebraic quotients and graded free resolutions.
- Students will be able to solve open-ended problems involving algebraic/combinatorial objects by formulating conjectures from examples and intution, then proving their conjectures using rigorous mathematical arguments.
- Students will be able to work together to collaboratively solve difficult mathematics problems.

A.D.A. Policy Statement: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. This legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring accommodation, please contact Student Disability Services.

If you require additional time on quizzes and/or exams, you must **contact me at the start of the course**. You will not be given extra time if you present this information just before an exam.

For additional information, visit `https://go.sdsu.edu/student_affairs/sds/`.

Copyright Policy: The handouts used in this course are copyrighted. By "handouts," I mean all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, in-class materials, review sheets, and additional problems sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless I expressly grant permission.

Scholastic Dishonesty: *An Aztec Does Not Lie, Cheat, or Steal, or Tolerate Those Who Do.* The San Diego State University Student Conduct Code will be enforced in this course. For the purpose of this course, cheating will be defined as (but not limited to) access or use of unauthorized material during exams and quizzes, collaboration between students during exams, quizzes or assignments for which group work is not allowed, perusal of another student's work during exams and quizzes, copying other student's work or allowing other students to copy your work on any assignment, quiz or exam, and having unauthorized programs or other information stored on calculators when these calculators are accessible during an exam or quiz. Note: Falsifying documentation is considered scholastic dishonesty and may result in a grade of F for the course.

For additional information, visit `http://go.sdsu.edu/student_affairs/srr/conduct.aspx`.

Land Acknowledgment: For millennia, the Kumeyaay people have been a part of this land. This land has nourished, healed, protected and embraced them for many generations in a relationship of balance and harmony. As members of the San Diego State University community, we acknowledge this legacy. We promote this balance and harmony. We find inspiration from this land, the land of the Kumeyaay.