Math 6690: Combinatorial and Computational Commutative Algebra, MWF 9:30-10:20, in MSCS 428

Professor: Chris Francisco
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Office Hours: Mon., 10:30-11:30, Tues., 1:00-2:30, Fri., 11:30-12:30, and by appointment.
Online Classroom (D2L) site: https://online.okstate.edu (then log in and find our course)
Prerequisite: Master's level algebra, something like MATH 5003 and 5013. Talk to me if you're unsure about your background.
Textbooks: Cox, Little, and O'Shea's *Ideals, Varieties, and Algorithms*, and Peeva's *Graded Syzygies*. Note that both texts are available for free download from the OSU Library. I can assist you in getting relatively cheap hard copies if you prefer that. You are not required to have either book, but it might be nice at least to have the electronic copies.

I am teaching this topics course because several graduate students requested something like it, so I will let you play a significant role in deciding some of the topics we cover. At a minimum, I expect to do the basics on Gröbner bases and their applications, Hilbert functions, and free resolutions of monomial ideals.

Syllabus Attachment: Please read the OSU syllabus attachment, available on the web at http://academicaffairs.okstate.edu/sites/default/files/Fall%202016%20Syllabus%20Attachment.pdf. This has a lot of important information, including instructions about disability accommodations. Please contact me privately during the first week of the course if you need accommodations as a result of a disability.

Grading: I will assign homework, probably 4-6 assignments, and that will comprise 80% of your grade. The homework is not intended to be burdensome. The other 20% will come from a 50-minute presentation you make to the class at the end of the semester. Earning 90% of the points guarantees an A for the semester, 80% a B, 70% a C, and 60% a D. I reserve the right to use discretion if you are on the borderline between two grades, considering class participation, improvement or decline during the semester, and my subjective judgment of your effort.

Attendance: Attendance is required. It is rare for a student to do well, particularly in a graduate class, if he or she misses class.

Conflicts: I will offer reasonable accommodation in the event that you miss a major assessment activity for a valid and documented reason, assuming documentation is provided **in advance unless absolutely impossible**. If you won't be in class when homework is due, turn it in early or give it to someone else to turn in prior to the deadline. I require proof of the reason for your absence (e.g., a doctor's note, proof of involvement in an OSU-sponsored activity, etc.), and you should not assume you will be eligible for accommodation unless I have explicitly approved your request.

Academic Honesty: Don't cheat. Don't copy off of other students, allow other students to copy your work, or present work you find in printed or electronic sources as your own. You may get help on homework from other people or sources but should write your solutions independently, without looking at anything someone else has produced. For questions, contact the Office of Academic Affairs, 101 Whitehurst, (405) 744-5627, http://academicintegrity.okstate.edu. I deal with cheating very harshly; don't take any chances.

What if I need help? You're in graduate school, and you've been through several courses already. You should know now that the most effective way to do homework is to try it on your own, work through some difficulties, and then speak with others in the class. I encourage you to do this. Of course, I am always willing to talk with you as well. The more you can figure out without me, however, the better you will learn the material. Start your homework early!

Topics covered: This is just a sample of the topics we will cover this semester since I will allow students some discretion as well.

- **Gröbner bases**: What are they? How are they used? What are the differences between polynomial rings in one variable and those in more variables?
- **Hilbert functions**: Counting in commutative algebra. Bounds for growth of ideals, connections to combinatorics and geometry. Historical work of Macaulay and advances made at OSU (especially J. Mermin).
- **Free resolutions**: Concentrating on monomial ideals. Connections to Hilbert functions. Lex ideals and their extremal behavior. Combinatorial approaches to resolutions.
- **Computer algebra systems**: How do you actually compute any of this stuff???

Course objectives:

- Learning the "Gröbner basics," meaning the fundamentals of the subject as well how these objects are useful in various parts of mathematics
- Connecting fundamental questions in commutative algebra with their analogues in combinatorics
- Understanding the historical importance that the key ideas in combinatorial commutative algebra play in problems spanning algebra, algebraic geometry, and combinatorics
- Using basic topological tools in algebra
- Writing clear, coherent mathematical arguments
- Learning to use a computer algebra system, like Macaulay 2, to do calculations that inform conjectures and methods of proof