MATH 328 # Computational Algebra and Algebraic Geometry **Fall 2012**

MWF 11:00 – 11:50 am King 239

Instructor: Susan Jane Colley
King 222
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Office Hours:

Monday	2:00 – 3:30 pm
Tuesday	2:30 – 4:30 pm
Wednesday	3:30 – 5:00 pm
Thursday	4:30 – 5:30 pm
Friday	2:30 – 3:30 pm

Also by appointment

Text: D. Cox, J. Little, and D. O'Shea, *Ideals, Varieties, and Algorithms,* 3rd. ed., Springer. This text is required and is available at the bookstore.

Goals: We will study certain topics from commutative algebra and elementary algebraic geometry that have become very important in the past few decades particularly in light of the increased power and speed of computers. In addition, we will explore (together and individually) how some of the key algebraic ideas can be applied to other areas in the mathematical sciences. Although our work will be primarily theoretical in nature, some computations will only be feasible by machine means.

Homework: There will be weekly, hand-in problem sets during the semester. You may work together on this homework, but you must submit your own write-up of the problems and indicate with whom you had any significant collaboration. No late assignments will be accepted (emergencies excepted, of course). Solutions to the hand-in problem sets will be available in King 203.

Examinations: There will be two open-book, take-home exams, tentatively **due on Wednesday, October 10 and Friday, November 16**. Please let me know as soon as possible if there is a problem with either of these dates. There will also be closed-book final exam on **Tuesday, December 18 from 9:00 to 11:00 am**.

Special Project: You will work either alone or with another student on an independent project related to computational algebra. The project may involve material

from the text or from other sources, or it may represent independent work. Each group will submit a written report (~ 5–7 pages) concerning the project and participate in a **Special Computational Algebra Session to be scheduled December 8 or 9**. Additional details concerning the special project will be forthcoming.

Participation: Since this is a small class, it is important that you come to class—on time and for (nearly) every meeting. Further, you should attempt to participate actively in class by asking questions, offering problem solutions, etc.

Grading:

Take-home midterms (each)	20%
Final exam	20%
Homework	20%
Special project and class participation	20%

(percentages of final grade)

Deadlines: I will try to be as clear as I can about the nature of assignments, and I will provide fair warning about when they are due. **Late assignments normally will not be accepted.** At the same time, I do understand that emergencies arise, so if *unforeseen* circumstances are interfering with your ability to complete some work in the course (e.g., significant illness, but *not* assignments for other classes), please contact me immediately, preferably *before* the assignment is due.

Online: Copies of assignments, handouts, etc. will be posted on the course Blackboard site. Go to **`blackboard.oberlin.edu`** (and your "Academic Hub") to access these materials.

Note: If you have a documented disability and wish to discuss academic accommodations, please contact me as soon as possible.

Outline of the Course

Introduction and basic notions (Chapter 1)	2.5 weeks
Gröbner bases (Chapter 2)	3.5 weeks
Elementary elimination theory (Chapter 3)	2.5 weeks
Correspondence between ideals and varieties (Chapter 4)	3 weeks
Additional topics	as time permits

Selected Bibliography

Here are some suggestions for supplementary reading. You may find some of these references helpful for putting together your project, but in no way should you feel constrained by them. An asterisk (*) indicates that the book is on reserve in Mudd.

BOOKS

*W. W. Adams and P. Loustaunau, *An Introduction to Gröbner Bases,* American Mathematical Society, Providence, 1994.

*T. Becker and V. Weispfenning, *Gröbner Bases: A Computational Approach to Commutative Algebra,* Springer, New York, 1993.

*D. Cox, J. Little, and D. O'Shea, *Using Algebraic Geometry,* Springer, New York, 1998.

*D. Eisenbud, *Commutative Algebra with a View Toward Algebraic Geometry,* Springer, New York, 1995.

*V. Ene and J. Herzog, *Gröbner Bases in Commutative Algebra*, American Mathematical Society, Providence, 2012.

*R. Fröberg, *An Introduction to Gröbner Bases*, Wiley, New York, 1997.

N. Koblitz, *Algebraic Aspects of Cryptograhy,* Springer, New York, 1998.

*H. Schenck, *Computational Algebraic Geometry,* Cambridge, 2003

J. van Lint and G. van der Geer, *Introduction to Coding Theory and Algebraic Geometry,* Birkhäuser, Basel, 1988.

PAPERS/ANTHOLOGIES

D. Bertsimas, G. Perakis, and S. Tayur, "A new algebraic geometry algorithm for integer programming," *Management Science* **46** (2000), no. 7, 999–1008.

*B. Buchberger and F. Winkler, eds., *Gröbner Bases and Applications,* Cambridge University Press, Cambridge, 1998.

*D. Cox and B. Sturmfels, eds., *Applications of Computational Algebraic Geometry,* American Mathematical Society, Providence, 1997.

P. Conti and C. Traverso, "Buchberger algorithm and integer programming," in *Applied Algebra, Algebraic Algorithms and Error-correcting codes (AAECC-9),* Lecture notes in Computer Science **539**, Springer, New York, 1991, 130–139.

D. Eisenbud and L. Robbiano, eds., *Computational Algebraic Geometry and Commutative Algebra,* Cambridge University Press, Cambridge, 1993.

S. J. Colley # Honor Code Policies **MATH 328**

Homework

You are permitted, even encouraged, to collaborate on homework. For homework that is not graded, feel free to consult anyone at all: your classmates, me, other students, friends, relatives, Barack Obama, Stephen Colbert (these last two not really). For homework that is to be handed in and graded, I expect you to be somewhat more careful. Specifically, you should continue to ask questions of me regarding homework problems and you may collaborate with one or two of your classmates (per assignment). Please do not undertake significant collaboration with more than two students without permission. If you do collaborate, you are expected to write your own solution to problems (i.e., not to copy) and to indicate the name(s) of any student(s) with whom you worked.

You may consult any written sources for hand-in homework, provided that you give appropriate citations. Please write your homework solutions with care.

Examinations

Unless specifically indicated otherwise, in-class tests are assumed to be closed-book. Collaboration of any sort (other than to ask me questions) will **not** be permitted. Take-home exams will have specific provisions for using books and notes, but, again, you are **not** to discuss the content of the exam with anyone other than me. Any time limits will be indicated with each test.

Independent Project

Obviously, your primary contacts for your project should be me and your partner. It is also acceptable for you to consult with others, provided you give appropriate citation in your poster presentation and your written report.

Honor Pledge

On every assignment that you submit for credit, you are expected to sign the Oberlin College Honor Pledge:

"I have adhered to the Honor Code on this assignment."

If you need clarification of the policies above, please do not hesitate to ask. Should you require some variation in these rules, you must discuss the matter with me well in advance of any assignment.

For general information about the Honor System at Oberlin, consult

<http://www.oberlin.edu/students/links-life/rules-regs.html>.