Meetings: MWF 1:10pm-2:00pm, BAINER 1060.

Instructor: Steffen Borgwardt

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http://www.math.ucdavis.edu/~sborgwardt/MAT165/

Office hours: Monday and Wednesday after class, i.e. 2:10-3:40pm, or by appointment. It will be most convenient for you to join me after class and walk with me to my office MSB 3238. The TA for this class is Lu Li, with office hours Friday 10-11am at room MSB 2141. We will be glad to help you with any questions, concerns, or problems.

Prerequisites and expectations: This class is intended for Math and CS majors in their junior or senior year. It is necessary that you have a solid idea of how to write proofs and true familiarity with computer programming (say as in ECS 30). In particular you will have to learn MAPLE. If in doubt please ask me about it.

You are expected to work outside the classroom programming, thinking about the theorems and exercises, etc. I estimate a minimum of three hours work at home per lecture. The most important thing is what YOU learn by doing. Math and CS are not spectator sports!

Text: The only mandatory text for this course is

- **Ideals, Varieties and Algorithms**, by Cox, Little and O'Shea, Springer UTM. (about 40$)

Other (more advanced, not required) references:

- **Using Algebraic Geometry**, by Cox, Little and O'Shea, Springer, GTM.

- **Modern Computer Algebra**, by von zur Gathen and Gerhard, Cambridge Univ,

- **Solving Polynomial Equations**, by Sturmfels, CBMS 97, American Math Soc.

Software: This class will use MAPLE as the software for class discussion, tests, homework, projects, etc. Due to logistic reasons, no other software will be allowed. A very useful resource, an e-book about MAPLE, is accessible to all UC Davis students for free in the electronic book (you do not need to buy this book!):


To access the book there is a SpringerLink free to all UC campuses

If you wish to access the book from outside campus internet, then you can do this using the VPN link of the library (go to the UCD library link).

Finally (NOT required) but a great text for all about MAPLE is

Description of this Course: This course has two goals:

1) To introduce undergraduate students to Algebraic/Symbolic Computation. This is the part of mathematics dedicated to algorithms where the answer is to be computed exactly. This is complementary to the area of numerical analysis (MATH 128ABC) where answers are computed with limited precision and error.

2) It is undeniable that computers are useful tools for finding counterexamples, discover patterns, and even proof theorems! Thus, the second goal of the course is to learn how computers are useful tools for mathematical research, experimentation and can even help to generate formal proofs automatically. In fact, knowing how to use computers can go a long way toward solving a math problem (e.g. see the site of Project Euler http://projecteuler.net).

Course outline: In general we will try to cover the first four chapters of the text book, plus some scientific applications.

(weeks 1-2) Motivation, Introduction to MAPLE and Symbolic Computation. The algebra of univariate polynomials, Euclid's algorithm and GCD of polynomials. Real and rational roots of univariate polynomials (Sturm sequences and Descartes's rule of signs).

FIRST PROJECT DUE.

(weeks 3-4) Ideals and Varieties, Multivariate systems of polynomial equations, monomial ideals, term orders and Multivariate Division Algorithm.

FIRST MIDTERM

(weeks 5-6) Groebner bases and Buchberger's algorithm

SECOND PROJECT DUE

(weeks 7-8) Solving systems of multivariate polynomial equations. Elimination theory, Hilbert's Nullstellensatz and unsolvable systems.

SECOND MIDTERM

(weeks 9-10) Applications. Engineering problems (e.g. Robotics), Automatic Theorem proving.

THIRD PROJECT DUE (last day of classes)

FINAL EXAM

Grading policy:

- There will be two midterms, first on Oct. 29, the second on Nov. 26, each counting 35 points. Several questions will come from homework assignments. There are also three projects (they will include programming for sure but also thinking and reading, researching etc). Each project is worth 15 pts. For both midterms and projects I will drop the lowest score. Finally there will be a final exam worth 35 points. It will take place Dec. 15 at 10:30am!!
- Important: I will regularly assign several problems for you to practice what is being covered. Although we will not collect those problems, you can count some will appear in each midterm and the final!!
- There are 100 points possible in this course. I will assign grades based on the statistical information obtained (I compute the mean, standard deviation, etc.) and set letter grades according with those numbers. Nevertheless, it is my rule that at least 60 points are required to pass the class.
- Please remember there are NO make-up exams or late homework, instead I am dropping the lowest scores as a compensation of possible problems or emergencies.
- Grades will be handled via the smartsite grade system. You can access grade information for this class via the internet. You can see your standing in the class, important statistics on exams, and your final grade there.