

RE: Math 165.

TO: UPC chair Jim Diederich

Proposed content and syllabus for Math 165.

This letter regards the new course Math 165 “Mathematics and Computers”. Here we write a proposed content of the course.

”Math and Computers” will be an introduction to algorithmic mathematics and computer generated/verified proofs. The course aims 1) to teach students some useful non-numerical algorithms arising through mathematics 2) illustrate the useful role that computers play in mathematical research. The course work will have a heavy part of experimentation and programming projects. Given the time, instructors are supposed to cover their selection of 3 to 4 algorithms and theory from the list below, aiming to cover at least one from each area listed.

- **Computation in Algebra**

Gröbner bases (Buchberger’s algorithm) , Resultants, and how to solve exactly a polynomial system. Real solutions, semi-algebraic sets.

Basic Computational Group Theory (determining order of a permutation group, finitely generated abelian groups).

Factorization of Polynomials (e.g Berlekamp’s algorithm, factorization of polynomials with integer coefficients)

Lattice Algorithms (LLL, Ferguson-Forcade).

- **Computation in Geometry**

Algorithms for manipulating linear inequalities

Convex hull algorithms

Basic Combinatorial Topology (e.g. computation of homology of simplicial complexes).

Basics of Automatic theorem proving, Schwartz-Zippel randomized testing of polynomial identities.

- **Computation in Combinatorics**

RSK Algorithm, Permutation statistics, generating random permutations.

Graph Colorings and Stable sets. Four color theorem algorithm.

Graph Planarity testing.

- **Computation in Analysis**

Automatic Symbolic Summation and Integration.

Random Numbers generation.

Monte Carlo methods, Metropolis Algorithm.

Fast Fourier Transform. Fast matrix and polynomial multiplication.

Sincerely,

Jesús De Loera and William Thurston