

Teaching Abstract Algebra with Sage

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MTH 412. Introduction to Algebraic Systems

- *Course Description—Introduction to the study of algebraic systems with particular emphasis on concrete examples of the basic algebraic structures, groups, rings, integral domains, and fields.*
- *Prerequisites—Discrete Structures (MTH 311) and Linear Algebra (MTH 317).*
- *The Students—Junior and senior math majors, especially preservice teachers.*

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MTH 412 Topics

- *Sets and Functions*
- *The Integers*
- *Groups, including cyclic groups, permutation groups, cosets and Lagrange's Theorem, isomorphisms, normal subgroups and factor groups, and homomorphisms.*
- *Rings, including polynomial rings and integral domains.*
- *Fields, including a review of vector spaces, algebraic extensions, and the field of constructible numbers.*

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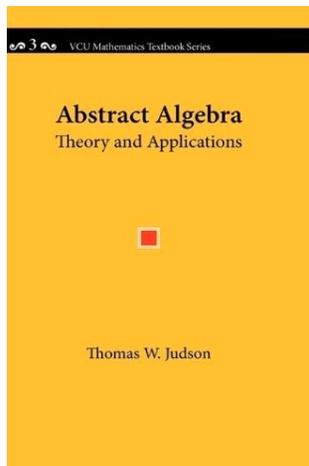
The Structure of the Course

- *MTH 412 met twice each week (75 minute class periods).*
- *One in-class exam and three take-home exams, including the final exam.*
- *Students kept a homework notebook that was handed at the end of each week.*
- *There were five Sage assignments.*
- *Students were asked to present homework solutions in class.*

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The Textbook

- *Abstract Algebra: Theory and Applications* was published by PWS in 1994.
- There was no second edition, and I obtained the copyright in 1997.
- AATA became open-source under the GDFL in 2008 and is now available as a Sage worksheet.



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Class Meetings

- *The original plan was to lecture for the first 20–25 minutes of each class and have students present problem solutions for the remainder of the class.*
- *The modified plan was to lecture on Tuesday and have students present problem solutions on Thursdays.*
- *The final plan was to lecture the last two weeks of the course.*

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What Went Right

- *The notebooks forced students to write their solutions more carefully.*
- *Having students present at the board was a good method of assessing what students could and could not do.*
- *Take home exams provided an opportunity to ask more in depth questions.*

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What Needs to Be Improved

- *Sage needs to be integrated into the classroom on a daily basis.*
- *Regular one-on-one meetings with students need to be scheduled outside of class.*
- *There needs to be a fine balance in class between lecturing, student presentations, and Sage.*
- *Sage needs to be accessible through a dedicated server.*

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Sage in the Abstract Algebra Classroom

- *Working with cyclic groups*
- *Working with permutation groups*
- *Working with polynomials*

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The Next Time I Teach Mth 412

- *Try to use Sage during every class period.*
- *All exams will be take-home exams, including the final exam.*
- *Students will keep a homework notebook to be handed at the end of each week.*
- *Sage assignments will be an integral part of the homework notebook.*
- *Students will be asked to present homework solutions in class.*

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What did the students think?

- *“SAGE was amazing!!! SAGE was free, I could use SAGE both at home and at school at any time of the day or night, I could use SAGE to help with other math classes, SAGE was easy to learn! I wish we could have gone over more examples in class, which kind of constituted that ‘overwhelmed’ feeling; however SAGE made up for this! I was able to use SAGE to construct examples of algebraic structures that we didn’t go over in class. SAGE really helped me to understand better what was going on with these structures. I would recommend that SAGE be used in future courses.”*

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Contact Information

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