# MATH 361, Fall 2016: Abstract Algebra

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**Instructor**

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**Class Meetings**

Tuesdays, Thursdays: 1:10 - 2:40 PM in Trexler 374
This course expects you to spend at least 12 hours of work each week inside and outside of class.

**Office Hours**

| | |
|---|---|
| Mondays | 8:45 – 9:45 AM |
| Tuesdays | 11:00 AM – 12:00 PM |
| Wednesdays | 9:30 – 10:30 AM |
| Thursdays | 11:00 AM – 12:00 PM |

and by appointment (email me)

**Course Objectives**

In this course, students will learn to create, analyze, and present logical arguments in the mathematical sciences. This will be done through a developed study of modern abstract algebra, including, but not limited to, groups, rings, and fields. Students will also learn that the ideas of 'adding', 'multiplying', and 'dividing' apply to many more objects than the numbers systems with which they are already familiar.

**Intended Learning Outcomes**

By the end of this course, successful students will be able to:

- use the basic definitions and properties of groups and rings;
- investigate the basic properties of a good range of examples in abstract algebra;
- construct simple proofs of results in abstract algebra;
- communicate mathematics, both in writing and in presentation.

**Required Materials**

Textbook: *Contemporary Abstract Algebra* by Joseph A. Gallian, 8th edition
All work on homework, quizzes, and tests should be typed or legible and done in pencil.

**Prerequisites**

Math 131 (Discrete Mathematics) and Math 201 (Linear Algebra)

**Course Grades**

The following table lists the weights for the various forms of assessment for this class.

| | |
|---|---|
| Participation | 16% |
| Quizzes | 10% |
| Homework | 20% |
| Midterm Exams (18% each) | 36% |
| Final Exam | 18% |

A grade scale will be determined after final grades are computed, but will be no worse than the scale given below. Attendance and class participation will be considered when determining marginal grades.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | B+ | 87-89 | C+ | 77-79 | D+ | 67-69 | | |
| A | 94-100 | B | 83-86 | C | 73-76 | D | 63-66 | F | 0-59 |
| A- | 90-93 | B- | 80-82 | C- | 70-72 | D- | 60-62 | | |

**Academic Integrity**

Students are expected to adhere to the Academic Integrity policies of Roanoke College. All work submitted for a grade is to be your own work! No collaboration is allowed on quizzes or tests. Unless otherwise stated, you many work together on the homework, but should write up your solutions separately.

Cell phones must be turned off prior to entering the classroom. Laptops may be used for note-taking during regular class sessions, if this seems useful to you, but you may not log on to the internet or to an email server unless specifically told to do so. The use of laptops and other electronic devices during an exam is strictly prohibited. This includes iPods, tablets, and phones. Any use of such devices during a quiz or exam will be considered a breach of academic integrity.

**Class Format**

This class will not be conducted in the typical lecture format. One of the best ways to learn mathematics is by doing mathematics, not just watching. This semester will be divided into 13 two-day "units," each roughly corresponding to a week of class (starting on Thursday and ending on Tuesday) and roughly consisting of material from one or two chapters of our textbook.

The first day of a unit will consist of ordinary lecture and small discussion on the material for the unit. After the lecture, homework will be assigned for the week. The second day of a unit will start with a short quiz and will be followed by in-class homework presentations.

**Homework**

Homework will be assigned on the first day of a unit, consisting of a mix of calculation problems and problems that require a formal proof. Enough problems will be assigned for us to discuss during the second day of a unit. Written solutions to a subset of the homework will be due at the start of the next class. Written proofs should be logically correct, consist of complete sentences, and be legible. If I cannot read it then it is wrong! Do not wait to start these until the night before the next class period!

Unless otherwise specified, you are encouraged to talk to other students in the class while working on your homework. You should, however, write up your solutions entirely by yourself and on your own. Mathematics is meant to be discussed, but the final write-up must be done on your own and in your own words.

**Participation & Presentations**

The key to learning a topic in mathematics is participation. Much of the second day of a unit will be students discussing problems and students presenting problems at the board. Don't be afraid! Your grade for presentations is not based on correctness, but rather based on developing skills for presenting mathematics and working with others. When it is not your turn at the board, expect to help your fellow classmate out; when it is your turn at the board, do the best you can! Writing down what you know and what you are trying to prove is a great way to begin. Note that most, if not all, of the presentations will be from homework problems, so if you are sure of your answer, volunteer yourself to work at the board.

Special "focus" problems will be designated from the master list for students to prepare. These will be assigned in pairs; this is a great time to get to know someone else in the class, collaborate on finding a solution, and teaching us all about it. Each person in the class should expect to present a problem roughly every other week.

Your participation grade will be based on your presentation skills, your contributions to class discussions and helping classmates during their presentations.

**Quizzes**

In order to do mathematics, you need to understand the language of mathematics. For this course in particular, it is very important you have basic definitions and theorems completely memorized. To encourage and reward quick memorization of these basic definitions and theorems, at the *start of the second day of a unit*, an in-class quiz will be given. If you have the basic definitions and theorems of a unit memorized, you should score an easy 100%.

**Exams**

This class will include two mid-terms and one final exam. Each exam (including the final) will not be cumulative but will focus primarily on material covered since the last exam (of course, this being a mathematics class, knowledge of all material from the class is required in some way or another). Each exam will be take-home; additional rules regarding the exam will be clearly stated on the exam itself. The dates for the exams will follow the schedule on page five (pending weather or class changes).

The final exam will also be take-home and given out on the last day of class. It will be due by 3pm on Tuesday December 13 and, again, will not be cumulative.

**Proof Writing**

One of the primary goals for this course is further development of your logical reasoning and proof writing skills. A proof should start by assuming the hypotheses given and end stating what was to be proved. Your job is to fill in this middle part by providing a prose paragraph (or more) that uses what you have learned to move from fact to fact to reach the end.

The final result should be polished and presented in mostly prose format with justification provided for each step that you provide. The use of shorthand symbols is extremely uncommon in polished and published proofs (for instance, I have never once seen the symbols for "therefore" and "such as" used in published mathematical proofs); when in doubt, it's best to words over symbols. The main exception is when defining sets, as in

$$X = \{x \in \mathrm{R} \mid \forall y \in C, x \geq y\}$$

which defines the set $X$ to be the set of all real numbers $x$ that happen to be less than all values $y$ in an already defined set $C$. Here, the symbolic use is typically set aside as above. In a true proof, this offset statement would be proceeded by the word "Let" and followed by more English prose to complete the sentence.

Feedback given on your proofs will be both mathematical and stylistic so that you can improve as the semester goes on. Grades will primarily based upon the mathematical correctness of your work. Stylistic suggestions for improvement will only affect your grade if the style of writing takes away from the ability to comprehend the mathematics.

**Attendance & Make-Up Work**

Attendance is critical to the understanding of the material in the course; it is both required and expected. Any absence that is not discussed with the instructor prior to the missed class is considered unexcused. I will assume that if you accumulate 4 unexcused absences you are not interested in completing the course. After the 3rd unexcused absence, you, your advisor, and the registrar will be warned that another absence will result in your removal from the class (DF). *When absent, excused or unexcused, you are responsible for all material covered in class. You will not be allowed to make up any work missed due to an unexcused absence.*

Late homework will be accepted without penalty as long as I have not started grading the homework; afterwards, late homework will be accepted with a 50% penalty (after grading) assessed. Take-home exams must be turned in on-time; a late-penalty (after grading) of $33\frac{1}{3}\%$ will be assessed per 24 hours late (rounded up); no exceptions.

**MCSP Conversation Series**

The MCSP Department offers a series of discussions that appeal to a broad range of interests related to these fields of study. These co-curricular sessions engage the community to think about ongoing research, novel applications and other issues that face our discipline. Members of this class are invited be involved with all of these meetings; however participation in at least **three** of these sessions is mandatory.

After attending, submit within one week of the presentation a one page paper reflecting on the discussion. This should not simply be a regurgitation of the content, but rather a personal contemplation of the experience. Each reaction paper will be counted as a quiz. A link for submission will be available on Inquire.

**Study Room**

The MCSP Study Room, Trexler 271, can be used by you and your friends to meet up so that you can work on homework together or prepare for tests. It is open virtually 24 hours a day, 7 days a week (very occasionally there are meetings in that room). Your student ID card should grant you access to Trexler Hall any time of day if the doors happen to be locked (use the card access point located by the first floor entrance facing the parking lot). Take advantage of this area and time, especially during weekdays when I am around (which is generally a lot)!

**Community**

Please feel free to become an active member of our department's community. Each of the three disciplines in our department has a student club and you should join! The Roanoke College Student Chapter of the Mathematical Association of America (or "Math Club" for short) meets every other week, plays and learns about games and hosts evening events and the annual Pi-Day celebration! Membership in our Math Club also grants membership into the MAA itself; one of the premiere professional mathematical organizations in the world.

In addition, our department offers a weekly tea time for students and faculty; feel free to stop by the MCSP Study Lounge (Trexler 271) for tea and cookies on Thursdays from 2:30 PM to 3:30 PM. Come meet other students as well as chat with the MCSP faculty members in a casual setting!

Tentative Course Schedule

| Unit | Date | | Chapter | Topic |
|---|---|---|---|---|
| 1 | Thu | Sep 1 | 0 | Integers and Equivalence Relations |
| 1 | Tue | Sep 6 | 0 | |
| 2 | Thu | Sep 8 | 1 & 2 | Introduction to Groups |
| 2 | Tue | Sep 13 | 1 & 2 | |
| 3 | Thu | Sep 15 | 3 | Finite Groups and Subgroups |
| 3 | Tue | Sep 20 | 3 | |
| 4 | Thu | Sep 22 | 4 | Cyclic Groups |
| 4 | Tue | Sep 27 | 4 | |
| 5 | Thu | Sep 29 | 5 | Permutation Groups |
| 5 | Tue | Oct 4 | 5 | **Midterm 1 Take-Home Begins** |
| 6 | Thu | Oct 6 | 6 | Isomorphisms |
| 6 | Tue | Oct 11 | 6 | |
| 7 | Thu | Oct 13 | 7 | Cosets and Lagrange's Theorem |
| | | | | **Fall Break** |
| 7 | Tue | Oct 25 | 7 | |
| 8 | Thu | Oct 27 | 8 | External Direct Products |
| 8 | Tue | Nov 1 | 8 | |
| 9 | Thu | Nov 3 | 9 | Normal Subgroups and Factor Groups |
| 9 | Tue | Nov 8 | 9 | **Midterm 2 Take-Home Begins** |
| 10 | Thu | Nov 10 | 10 | Group Homomorphisms |
| 10 | Tue | Nov 15 | 10 | |
| 11 | Thu | Nov 17 | 12 & 13 | Introduction to Rings and Integral Domains |
| 11 | Tue | Nov 22 | 12 & 13 | |
| | | | | **Thanksgiving Break** |
| 12 | Tue | Nov 29 | 14 | Ideals and Factor Rings |
| 12 | Thu | Dec 1 | 14 | |
| 13 | Tue | Dec 6 | 15 | Ring Homomorphisms |
| 14 | Thu | Dec 8 | 15 | Final Exam Take-Home Begins |
| | Tue | Dec 13 | | **Final Exam due 3 PM** |