MATH 4030 - FOUNDATIONS OF ALGEBRA

Instructor: Adam Boocher
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Office: JWB 315
Website: *Canvas*
Class: MW 3:00 - 4:20 LCB 121

Office Hours: to be held in my office, JWB 315;

Monday after class;
Tuesday 11am - noon
and by appointment (really, feel free to email me and we'll find a time)

Textbook: Lecture notes were written for this course by Aaron Bertram. They are available at

http://www.math.utah.edu/~bertram/courses/4030/

I'll likely deviate from these notes from time to time so class attendance is essential for this course.

Important Dates:

Midterm 1	September 21	In class
Midterm 2	October 26	In class
Midterm 3	November 30	In class
Take Home Final / Project	Due December 14	Noon

(Exam dates are tentative at the moment)

Course Description: We will study some of the basic algebraic structures that arise in mathematics, going from concrete examples to more general and abstract concepts. First we will study various concepts of numbers: natural numbers and the principle of induction, then integers and rational numbers, then real and complex numbers. The main part of the course will be on polynomials and their roots. This will bring us to algebraic numbers, and to the concepts of rings and fields. We will see finite fields and how they help us understand polynomials. The culmination of the course will be the application of these concepts to the proof of the impossibility of certain ruler and compass constructions, for example, the impossibility of trisecting certain angles by ruler and compass.

Course Objectives: At the end of this course, the students will:

(1) Know definitions and examples of rings (integers) and fields (rational and real numbers).
(2) Demonstrate understanding of field axioms.
(3) Understand rational numbers as equivalence classes of integer fractions (ordered pairs of integers with appropriate constraints), define the operation of addition and multiplication and prove that so defined the set of rational numbers with the given operations forms a field.
(4) Define real numbers as limits of sequences of real numbers, define operations on real numbers using geometric notions and be able to prove that a set of real numbers with so defined operations forms a field.
(5) Students will be able to convert between repeating decimals and fractional representations of rational numbers. They will be able to explain which rational numbers correspond to terminating decimals.
(6) Use the isomorphism between $\mathbb{C}$ and $\mathbb{R}^2$ and polar coordinates to offer geometric interpretation for multiplication of complex numbers.
(7) Find n-th roots of any complex number.
(8) Know how to extend the ideas from rational and real numbers to the field of polynomials and rational functions.
(9) Be able to articulate how the familiar notion of degree of a polynomial and Euclidean algorithm generalize to a degree function and Euclidean domains.
(10) Prove and use the rational root test.
(11) Implement some tests to determine whether a polynomial is prime in Q[x].
(12) Understand the constructible number theorem and know how to construct square roots of constructible numbers.

Grading Policy: Your grade will be determined based on

- Homework and Class Participation 20%
- Midterm 1 20%
- Midterm 2 20%
- Midterm 3 20%
- Final 20%

Homework You are encouraged to work on homework in groups of 2 - 4 people. One person should act as the scribe each week and this person should change from week to week. I suggest that Friday during our scheduled class time would be a good time to work together on the homework problems. Late homework will not be accepted. However, I will drop the lowest homework score.

Strategies for Success: This class will be challenging - you will learn some abstract definitions and will be required to have a deep understanding. You'll be asked to solve problems and the solutions will require creativity. Many problems won't be possible to solve at the first or second attempt. While working on the homework, I encourage you to think about how these experiences can be useful in future teaching. What is the experience of groupwork like when one student understands everything, while the other groupmates struggle? What strategies can you take as a student / teacher in this vein?

Finally, I find that daily practice is the best pathway to success in a number of areas - consider music, meditation, yoga, etc. Consider making a commitment to think about mathematics on your own each day. Most days this will mean working on the homework, or participating in discussion. But if you find yourself busy with life's other demands, even five minutes of thinking "What was it we did in class the other day?" will do wonders.

There will be no extra credit in this course, but notice that participation is a component of your grade. Success is very strongly correlated with effort, and I can promise that if you are struggling in this course then attending office hours as well as volunteering in class will be very useful to your understanding in the course.

Academic Integrity: All University of Utah policies regarding ethics and honorable behavior apply to this course.

Resources for you:

1.) ADA: The University of Utah is fully committed to affirmative action and to its policies of nondiscrimination and equal opportunity in all programs, activities, services, and employment without regard to race, color, national origin, sex, age, disability, gender identity/expression, religion, sexual orientation, and status as a protected veteran. The University seeks to provide equal access to its programs, services, and activities for people with disabilities. Reasonable prior notice is needed to arrange accommodations. Evidence of practices not consistent with these policies should be reported to the Universitys Title IX/ADA/Section 504 Coordinator: Director, Office of Equal Opportunity and Affirmative Action, 201 S Presidents Cr., Rm 135, Salt Lake City, UT 84112. 801-581-8365 (V/TDD).

2.) Wellness Center: Are you concerned about stress, sleep difficulties, anxiety, depression, cultural differences, relationship difficulties, balancing work and school, or finances? Would you like to perform better in class, help a friend in distress, or learn more about physical activity or nutrition? Contact the Center for Student Wellness; `wellness@sa.utah.edu`; `www.wellness.utah.edu`; 801-581-7776.

3.) Veterans: If you are a student veteran, I want you to know that the U of Utah has a Veterans Support Center on campus. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: `http://veteranscenter.utah.edu/`. Please also let me know if you need any additional support in this class for any reason.

4.) LGBTQ: If you are a member of the LGBTQ community, I want you to know that my classroom is a safe zone. Additionally, please know that the U of Utah has an LGBT Resource Center on campus. You can visit their website to find information about the support they can offer, a list of events through the center and links to additional resources: `http://lgbt.utah.edu/`. Please also let me know if you need any additional support in this class for any reason. My pronouns are (he/him/his) and please let me know if you have preferred pronouns.

5.) Mathcenter: There is free tutoring available at the Math Tutoring Center, located in room 155 of the T. Benny Rushing Mathematics Center (adjacent to the LCB and JWB). To let the tutors know that you need help, simply put up one of the flags. If you find that you'd prefer more personalized attention than our tutoring center can give, try the ASUU Tutoring Center (7 dollars an hour), 330 SSB, or pick up a private tutor list from the math department office (233 JWB). For more information look here: `http://www.math.utah.edu/ugrad/mathcenter.html`.