

Department of Mathematics  
College of Liberal Arts and Sciences  
Iowa State University

## Math 504 – Abstract Algebra I – Fall 2022

Group theory (groups, homomorphisms, group actions, products). Ring theory (rings, homomorphisms, integral domains, polynomials). Emphasis on writing proofs.

**Lectures:** MWF 12:10pm – 1:00pm in Carver 0124

**Instructor:** Dr. Jonas Hartwig — Office: Carver 470 — Email: [jth@iastate.edu](mailto:jth@iastate.edu) — Website: [jthartwig.net](http://jthartwig.net) — Office Hours: MF 3:10pm–5:00pm

**Prerequisites:** MATH 302. Specifically, it is expected that you have some familiarity with concrete groups such as cyclic, abelian, dihedral, symmetric and alternating groups; the notion of a homomorphism, and have seen some elementary ring theory.

**Reading:** Main text: *Abstract Algebra* 3rd ed., by Dummit & Foote, Chapters 0–9. Additional notes may be provided if needed. This course will require hard work. We will not have time to cover everything you need to know during lectures. It is expected that you carefully study the relevant topics before and after each lecture.

### Course Format

**Two Midterms (20% each):** During lecture, on Fri Sep 30 and Fri Oct 28.

**Final Exam (25%):** Cumulative. Fri Dec 16, 9:45–11:45am

**Homework (35%):** Written homework will be assigned and collected every week. You may discuss problems with others as long as each of you write your own solutions.

**Grading:** 79% or better guarantees at least a B-. This threshold might be adjusted down at the end of the semester.

**Dead week:** Lectures will continue during deadweek. There will not be a homework due, but we might cover new material.

### Lecture Plan

Group Theory, Basics	Ch. 0–3	5 weeks, followed by Midterm 1
Group Actions and Products	Ch. 4–6	5 weeks, followed by Midterm 2
Ring Theory	Ch. 7–9	5 weeks, followed by Final Exam

### Class Policies and Expectations

**Reading:** You are expected to carefully read and study the relevant sections in the book before and after each lecture.

**Late assignments:** No homework extensions will be granted unless written proof can be provided of a serious emergency (such as hospitalization) preventing you from working on and completing the homework in time.

**Extra Help:** If you need extra help, come to my office hours. If you cannot make it to office hours, send me an email (jth@iastate.edu) and ask to schedule a meeting. Every possible effort will be made to find a time to help you. You can also send short questions via e-mail.

## Learning Objectives and Outcomes

1. Integers: Congruence, Division Algorithm, unique factorization, greatest common divisor and least common multiple, Euclidean Algorithm.
2. Groups (basic theory): groups, subgroups, normal subgroups, homomorphism, isomorphism, quotient groups, (semi-)direct products, cosets and counting, Lagrange's Theorem, subgroup generation, the Isomorphism Theorems, the Correspondence Theorem.
3. Examples of groups: permutation groups, groups of symmetries, matrix groups, dihedral and quaternion groups.
4. Permutation groups: Cayley's Theorem, permutations as products of disjoint cycles and consequences for the structure of permutation groups, permutations as products of transpositions, alternating groups, simplicity of  $A_n$  for  $n > 4$ .
5. Abelian groups: structure of cyclic groups, free abelian groups and the Fundamental Theorem of Finitely Generated Abelian Groups.
6. Groups: structure theory, group actions on sets, stabilizers, the Orbit-Stabilizer theorem and the class equation, Cauchy's Theorem, Sylow Theorems.
7. Rings (basic theory): subrings, ideals, homomorphism, isomorphism, quotient rings, direct products and sums, isomorphism and correspondence theorems, division rings and fields, examples of rings, rings of matrices.
8. Rings (advanced theory): properties of ideals, maximal and prime ideals, the Chinese Remainder Theorem, integral domains, relationship between maximal ideals and fields and between prime ideals and integral domains, factorization in commutative rings, irreducible and prime elements, Euclidean Domains, Principal Ideal Domains, Unique Factorization Domains, polynomial rings.

## General Policies

### Free Expression

Iowa State University supports and upholds the First Amendment protection of freedom of speech and the principle of academic freedom in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.

### Public Health

If you are not feeling well, you should stay home and focus on your health. Should you miss class due to illness, it is your responsibility to work with your instructor to arrange for

accommodations and to make up coursework, as consistent with the instructor's attendance policy.

You may choose to wear a face mask and/or receive the COVID-19 vaccine and boosters, as well as other vaccines such as influenza, but those options are not required. Thiel Student Health Center will continue to provide COVID-19 vaccinations free-of-charge to students. The university will continue to offer free masks and COVID-19 test kits during the fall 2022 semester. Other wellbeing resources for students are available at: <https://www.cyclonehealth.iastate.edu/wellbeing-resources/>

Public health information for the campus community continues to be available on Iowa State's public health website. All public health questions should be directed to [publichealthteam@iastate.edu](mailto:publichealthteam@iastate.edu).

### **Academic Dishonesty**

The class will follow Iowa State University's policy on academic misconduct (5.1 in the Student Code of Conduct). Students are responsible for adhering to university policy and the expectations in the course syllabus and on coursework and exams, and for following directions given by faculty, instructors, and Testing Center regulations related to coursework, assessments, and exams. Anyone suspected of academic misconduct will be reported to the Office of Student Conduct in the Dean of Students Office. Information about academic integrity and the value of completing academic work honestly can be found in the Iowa State University Academic Integrity Tutorial.

### **Accessibility Statement**

Iowa State University is committed to advancing equity, access, and inclusion for students with disabilities. Promoting these values entails providing reasonable accommodations where barriers exist to students' full participation in higher education. Students in need of accommodations or who experience accessibility-related barriers to learning should work with Student Accessibility Services (SAS) to identify resources and support available to them. Staff at SAS collaborate with students and campus partners to coordinate accommodations and to further the academic excellence of students with disabilities. Information about SAS is available online at [www.sas.dso.iastate.edu](http://www.sas.dso.iastate.edu), by email at [accessibility@iastate.edu](mailto:accessibility@iastate.edu), or by phone at 515-294-7220.

### **Contact Information**

If you are experiencing, or have experienced, a problem with any of the above issues, email [academicissues@iastate.edu](mailto:academicissues@iastate.edu).