

## Math 412–413 Introduction to Abstract Algebra (3–3)

**Catalog description.** Introduction to basic algebraic structures. Groups, finite groups, abelian groups, rings, integral domains, fields, factorization, polynomial rings, field extensions, quotient fields. Emphasis on writing instruction. (These topics are covered in the year sequence Math 412–413.)

**Pre for 412.** 311 and 321; or consent.

**Pre for 413.** 412; or consent.

**Standard textbook.** Hungerford's *Abstract algebra: an introduction, Third edition*

This textbook takes the ‘rings first’ approach, so 412 mostly covers ring theory, while 413 typically does group theory and field theory. Specifically, 412 covers the material in chapters 1–7 of Hungerford's book.

Every mathematics major should take Math 412–413 unless they have definitely decided not to do graduate work. The course is self-contained, and knowledge from calculus or linear algebra is needed only occasionally for illustrations and examples. The material is abstract and rigorous, however, and requires some mathematical maturity.

**Ring Theory.** Definition and examples, polynomial rings, ideals and quotient rings, direct products, euclidean domains, principal ideal domains, unique factorization domains. (Chapters 1–6, 10 of Hungerford)

**Group Theory.** Definition and examples, permutation groups, the Cayley representation theorem, normal subgroups, quotient groups, direct products, the Isomorphism Theorems, abelian groups and the classification of finite abelian groups, the Sylow theorems. (Chapters 7–9 of Hungerford)

**Field Theory.** Definition and examples, characteristic, vector spaces, quotient fields, polynomials over a field, construction of finite fields, field extensions and Galois Theory. (Chapters 11–12 of Hungerford)

Math 412–413 is taught only in a writing-intensive format. Students will be required to do a substantial amount of mathematical writing. This course will be conducted so as to satisfy the hallmarks for writing-intensive classes, as described here: <http://manoa.hawaii.edu/mwp/faculty/hallmarks>.

**Course Objectives and Student Learning Outcomes.** Upon successful completion of Math 412 and 413, the student will have an understanding of the basic theory covering groups, rings, and fields, and be able to apply this knowledge in other areas of mathematics.

**Program Objectives.** The successful student will have learned one advanced topic in depth (emphasis). There is a continued emphasis on understanding and writing proofs. Examples and counterexamples contribute to the understanding of the course material, and some reading without supervision is expected.