

# An Introduction to Modern Algebra: Part 1a

## Syllabus

The University of Iowa  
The College of Liberal Arts and Sciences  
Department of Mathematics  
14 MacLean Hall

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### Description of Course:

This course is the first of a four sequence series that serve as an undergraduate introduction to modern algebra. It is eight weeks long and will focus on the first three chapters of the third edition of Thomas Hungerford's Abstract Algebra *An Introduction*. This course builds up to the introduction of rings as a mathematical object by first focusing on the themes of arithmetic and congruence as they relate to the integers.

The first four weeks focus on topics related to arithmetic and congruence in the integers. Topics in Weeks 1 and 2 include the division algorithm, divisibility, prime numbers, the greatest common divisor of two numbers, and the fundamental theorem of arithmetic. Weeks 3 and 4 focus on congruence by introducing it as an equivalence relation on the integers, and showing how to perform operations using modular arithmetic. The final four weeks introduce rings. Commutative rings, rings with identity, integral domains, fields, subrings, and sub fields are discussed. Mappings between rings are also focused on in the final two weeks, with attention paid to isomorphic rings and ring homomorphisms.

### Prerequisites:

Students enrolling in this course should be prepared for an upper-level mathematics course by having completed the following courses below:

1. Calculus 1
2. Calculus 2
3. \*Foundations of Mathematics or equivalent
4. Multivariable Calculus
5. \*Linear Algebra

For requirement 3 above, any course that introduces logic, proof, set theory, functions, relations, induction, cardinal numbers, and number theory is sufficient. It is expected that this will not be the student's first introduction to proof writing. Note that Linear Algebra is suggested but is not necessary. It can be taken concurrently with this course or not have been taken at all.

### Course Objectives:

1. Make sound arguments and write effective proofs based on careful mathematical reasoning.
2. Effectively communicate mathematics using correct language and notation.
3. Understand the relationship between congruence and arithmetic in the integers and properties of rings.
4. Understand congruence classes as an equivalence relation on the integers
5. Understand the structure of the integers mod  $p$

6. Be able to perform arithmetic and multiplication in the integers mod  $n$
7. Be able to determine if a given element is a unit or a zero divisor
8. Be able to determine if a given set is a ring.
9. Be able to classify a given ring as commutative, a ring with identity, a field, or an integral domain.
10. Be able to prove that a given subset of a ring is a subring.
11. Be able to manipulate ring homomorphisms.
12. Use definitions of injective, surjective, and homomorphism to determine if a given mapping defines a ring isomorphism.
13. Understand how properties can be preserved by ring homomorphisms and isomorphisms.

**Required Texts:**

- Text: Abstract Algebra *An Introduction* by Thomas W. Hungerford 3<sup>rd</sup> edition (ebook or physical text) ISBN-10: 1285374312; ISBN-13: 9781285374314

**Purchasing options:**

1. eBook available on Amazon.com and Cengage.com for rental starting at \$18.99 for four months
2. Physical text available on Amazon.com and Cengage.com for rental starting at \$31.49 for four months
3. Book available for purchase from Cengage.com for \$199.95, copies are also available from individual sellers on Amazon.com and eBay.com

**Calculation of Grade:**

Homework	50%
Quizzes	20%
Reflection Papers	10%
Participation	10%
Discussion Posts	10%

**Grading System:**

Grades will be assigned on a curve, which will be determined at the end of the course. The curve will not be lower than the following:

93-100%	90-92.9	87-89.9	83-86.9	80-82.9	77-79.9	73-76.9	70-72.9	67-69.9	63-66.9	60-62.9	less than 60
A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

Note that no A+ will be given in this course.

**Homework:**

The majority of the course grade will come from homework assignments. Homework will be due on Monday nights at 11:59pm via upload onto ICON. Late homework will not be accepted. You are encouraged to work with classmates by communicating in the discussion forums or using a video conferencing software such as Zoom or Skype.

**Quizzes:**

There will be a quiz due each Thursday at 11:59pm. Quiz questions will be available via PDF on the course site at the beginning of the week. Quizzes are designed to be accessible after reading the course notes and watching the corresponding videos. For credit, submission of the quiz must occur through the quiz link on the ICON site, uploads of the PDF version provided will not be accepted.

**Reflection Papers:**

This course will require two reflection papers, one due during Week 4 and one due after Week 8. In each you will have to write a one page reflection on a given prompt. These reflection papers are intended to get you to think about the big picture of concepts we are discussing in the course and the connections between abstract algebra and elementary themes like arithmetic and congruence.

**Participation:**

Participation grades will be based on attendance to the weekly course meeting Thursdays from 2:00pm-3:30pm. It is expected that you will contribute to meaningful discussion through comments and questions about concepts from the course notes, the weekly homework assignment, or the quiz. The weekly course meeting is not optional. We will meet on Zoom.

**Discussion Posts:**

Each discussion post prompt will be given at the beginning of the week and due by noon on Friday. This first week there will also be an introductory post so that you can get to know your classmates. There will be two to three questions each week related to the topics covered in the course notes. These posts are intended to have you think more critically about the topics from the homework and to discuss your ideas with your classmates.

**Tentative Schedule:**

<b>Week</b>	<b>Topics</b>	<b>Textbook</b>	<b>Assignment</b>	<b>Due Date</b>	<b>Time</b>
<b>1</b>	Well-Ordering Axiom, Division Algorithm, Division, Greatest Common Divisor, Relatively Prime	§1.1-1.2 Pg.1-10	Introduction Post	Tuesday	11:59pm
			Quiz 1	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>2</b>	Euclidean Algorithm, Properties of Greatest Common Divisor, Primes, Fundamental Theorem of Arithmetic	§1.2-1.3 Pg.10-24	Homework 1	Monday	11:59pm
			Quiz 2	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>3</b>	Congruence Classes in the Integers, Congruence as an Equivalence Relation, Modular Arithmetic	§1.3-2.1 Pg.24-32	Homework 2	Monday	11:59pm
			Quiz 3	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>4</b>	Addition and Multiplication in Integers mod n, Units, Zero Divisors	§2.2-2.3 Pg.32-42	Homework 3	Monday	11:59pm
			Quiz 4	Thursday	11:59pm
			Reflection Paper	Friday	12:00pm
<b>5</b>	Rings, Commutative Rings, Rings with Identity, Integral Domains, Fields, Direct Products of Rings	§3.1 Pg.42-51	Homework 4	Monday	11:59pm
			Quiz 5	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>6</b>	Subrings, Subfields, Arithmetic in Rings, Units and Inverses, Zero Divisors, Integral Domains and Fields	§3.1-3.2 Pg.51-70	Homework 5	Monday	11:59pm
			Quiz 6	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>7</b>	Isomorphic Rings, Injective Maps, Surjective Maps, Bijective Maps, Rings Isomorphisms	§3.3 Pg.70-75	Homework 6	Monday	11:59pm
			Quiz 7	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>8</b>	Ring Homomorphisms, Properties of Homomorphisms, Preservations of Properties under Isomorphism and Homomorphism	§3.3 Pg.75-83	Homework 7	Monday	11:59pm
			Quiz 8	Thursday	11:59pm
			Discussion Post	Friday	12:00pm
<b>*</b>			Homework 8	Monday	11:59pm
			Reflection Paper	Wednesday	12:00pm

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## Additional Policies & Resources

### Administrative Home

The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Academic Policies Handbook at <http://clas.uiowa.edu/students/handbook>.

### Electronic Communication

University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondences ([Operations Manual, III.15.2](#), k.11).

### Accommodations for Disabilities

The University of Iowa is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (which includes but is not limited to mental health, attention, learning, vision, and physical or health-related conditions). A student seeking academic accommodations should first register with Student Disability Services and then meet with the course instructor privately in the instructor's office to make particular arrangements. Reasonable accommodations are established through an interactive process between the student, instructor, and SDS. See <http://sds.studentlife.uiowa.edu/> for information.

### Academic Honesty

All CLAS students or students taking classes offered by CLAS have, in essence, agreed to the College's [Code of Academic Honesty](#): "I pledge to do my own academic work and to excel to the best of my abilities, upholding the [IOWA Challenge](#). I promise not to lie about my academic work, to cheat, or to steal the words or ideas of others; nor will I help fellow students to violate the Code of Academic Honesty." Any student committing academic misconduct is reported to the College and placed on disciplinary probation or may be suspended or expelled ([CLAS Academic Policies Handbook](#)).

### CLAS Final Examination Policies

The final examination schedule for each class is announced by the Registrar generally by the fifth week of classes. Final exams are offered only during the official final examination period. **No exams of any kind are allowed during the last week of classes.** All students should plan on being at the UI through the final examination period. Once the Registrar has announced the date, time, and location of each final exam, the complete schedule will be published on the Registrar's web site and will be shared with instructors and students. It is the student's responsibility to know the date, time, and place of a final exam.

### Making a Suggestion or a Complaint

Students with a suggestion or complaint should first visit with the instructor (and the course supervisor), and then with the departmental DEO. Complaints must be made within six months of the incident ([CLAS Academic Policies Handbook](#)). The DEO for the Department of Mathematics is Dr. Maggy Tomova. Her office is in 14 MacLean Hall and her email is [maggy-tomova@uiowa.edu](mailto:maggy-tomova@uiowa.edu).

### Understanding Sexual Harassment

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI [Office of the Sexual Misconduct Response Coordinator](#) for assistance, definitions, and the full University policy.