جامعة نيويورك أبوظبي
NYU | ABU DHABI

MATH-UH 3210

Abstract Algebra 2

Spring 2024

Credits: **4**

Prerequisites: Abstract Algebra 1 - MATH-UH 2012

Corequisites: None

Faculty Details	Professor
Name	Sofiane Bouarroudj
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Workspace	A2-115
Office Hours	M and W/02:00pm – 03:00pm

Course Details	Day/Time	Location
Lecture	M and W/09:55am – 11:10am	West Admin Room 004
Recitation	By appointment (with Quentin Ehret)	
Mid Term Exam	March 20th	Classroom
Final Exam	TBD	TBD

Course Description

This course counts toward the following NYUAD degree requirements:

Majors > Mathematics > Mathematics Required Courses

This course is a continuation of the study of algebraic structures started in Abstract Algebra 1. The notion of rings, and fields are thoroughly studied, as well as polynomials over rings such as the ring of integers. This course develops ideas to prepare the students to study Galois theory, one of the most important theories in Algebra. The topics include Euclidean domains, principal ideal domains, unique factorization domains, imaginary and real quadratic number fields, extension fields and roots of polynomials, constructions with straight edge and compass, and elements of Galois theory.

Course Learning Outcomes and Link to Program Learning Outcomes (PLOs)

Students who successfully complete this course will be able to:	CLO Level of Contribution	Linked to X Major PLOs[1]
1. Define, discuss, solve non-trivial problems related to and prove simple (but non-trivial) theorems about:	High	PLO1
○ Ideals and ring homomorphisms ○ Quotient rings ○ Prime and maximal ideals ○ Polynomial rings over fields and rings	Low	PLO2
2. Comprehend the concept of irreducible polynomials, and learn how to carry out the polynomial division algorithm.	High	PLO1
3. Learn, Understand, and Solve problems related to:	Low	PLO2
○ Extensions of fields ○ Field extensions via quotients in polynomial rings ○ Automorphisms of fields ○ Finite Fields	High	PLO1
4. Differentiate between Fields of characteristic zero and Fields of prime characteristic.	Low	PLO2
5. Comprehend, communicate, and solve problems related to Galois theory, and apply it to show the insolvability of the quintic equation.	High	PLO1
	High	PLO1
	Low	PLO2, PLO4

Teaching Methodologies

There will be one midterm exam on March 20th, and the final exam on TBA. No scientific calculators are allowed during the exams. Four Quizzes will be given throughout the semester to assess learning of weekly topics. In addition, there are homework assignments that include problems that must be solved and submitted on paper each week.

Graded Activities

Activity Detail	Grade Percentage	Submission Date/Week	Linked to Course Learning Outcome(s)
Written assignments	15 %	Every week	1,2,3,4,5
Quizzes	15 %	4 quizzes to TBA	1,2, 3,4,5
Midterm Exam	30%	March 20th	1,2
Final Exam	40%	TBD	1,2,3,4,5

[1] See Appendix 1

Required Bookstore Texts

- Michael Artin, Algebra, 2nd edition, Pearson, 2010.

Other Required Readings

- S. Lang, Algebra, Springer-Verlag New York, 2002
- B.L. van der Waerden, Algebra, Springer-Verlag New York, 1990
- N. Jacobson, Basic Algebra I, II, Dover Books in Mathematics, 2009

Academic Policies

Attendance: Attendance will regularly be taken during each lecture. All students are expected to attend all lectures. More than two non-justified absences will reduce the average quizzes' marks by 1 mark.

Grade Distribution: Students need to obtain a grade of C or better to count the course towards their intended degree for required courses or economics electives. Course percentages will be translated into letter grades based on these intervals:

A	A-	B+	B	B-	C+	C	C-	D	F
[100;92]	(92;90]	(90;87]	(87;83]	(83;80]	(80;75]	(75;70]	(70;65]	(65;50]	(50;0]

Integrity: At NYU Abu Dhabi, a commitment to excellence, fairness, honesty, and respect within and outside the classroom is essential to maintaining the integrity of our community. By accepting membership in this community, students, faculty, and staff take responsibility for demonstrating these values in their own conduct and for recognizing and supporting these values in others. In turn, these values create a campus climate that encourages the free exchange of ideas, promotes scholarly excellence through active and creative thought, and allows community members to achieve and be recognized for achieving their highest potential.

Students should be aware that engaging in behaviors that violate the standards of academic integrity will be subject to review and may face the imposition of penalties in accordance with the procedures set out in the NYUAD policy: https://students.nyuad.nyu.edu/campus-life/student-policies/community-standards-policies/academic-integrity/

Moses Center for Student Accessibility

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https://www.nyu.edu/students/communities-and-groups/students-with-disabilities.html

Contact: mosescsd@nyu.edu

Course Schedule

Below is a provisional schedule of the topics to be covered in this course. Dates are subject to confirmation and may change. Please make sure to go over the readings before coming to class.

Week	Session	Topic	Reading
1	Jan 22nd	Definition of a Ring, Homomorphisms and Ideals, Quotient Ring, Product Rings, Maximal Ideals (Revision)	Textbook
	Jan 24th	Factoring Integers	Textbook
2	Jan 29th	Unique Factorization Domain	Textbook
	Jan 31st	Gauss's Lemma	Textbook
3	Feb 05th	Factoring Integers Polynomials, Gauss Primes	Textbook
	Feb 07th	Gauss Primes (continued), Algebraic Integers	Textbook
4	Feb 12th	Factoring Algebraic Integers, Ideals in $\mathbb{Z}\sqrt{-5}$	Textbook
	Feb 14th	Ideal Multiplication, Factoring Ideals	Textbook
5	Feb 19th	Prime Ideals, and prime Integers, Ideal Classes	Textbook
	Feb 21st	Computing the Class Group	Textbook
6	Feb 26th	Real Quadratic Fields	Textbook
	Feb 28th	Fields, Algebraic and Transcendental Elements	Textbook
7	Mar 04th	The Degree of a Field Extension, Finding the Irreducible Polynomial	Textbook
	Mar 06th	Ruler and Compass Constructions, Adjoining Roots	Textbook
8	Mar 20th	**MIDTERM March 20th, 2024**	?????
	Mar 25th	Finite Fields , Primitive Elements	Textbook

Week	Session	Topic	Reading
9	Mar 27th	Symmetric Functions	Lecture Notes
	Apr 01st	The Discriminant, Splitting Fields	Lecture Notes
10	Apr 03rd	Isomorphisms of Field Extensions	Lecture Notes
	Apr 08th	Fixed Fields	Lecture Notes
11	Apr 15th	Galois Extensions	Lecture Notes
	Apr 17th	Galois' Theorem	Lecture Notes
12	Apr 22nd	Cubic Equations	Lecture Notes
	Apr 24th	Quartic Equations	Lecture Notes
13	Apr 29th	Root of Unity	Lecture Notes
	May 01st	Kummer Extensions	Lecture Notes
14	May 06th	Quintic Equations	Lecture Notes
	May 08th	Quintic Equations (continued)	Lecture Notes

Appendix 1

Math Major Program Learning Outcomes (PLOs)

PLO 1 Apply the fundamental theorems of Analysis, Algebra and Geometry (Knowledge, Autonomy & Responsibility, Self-development).

PLO 2 Identify and apply appropriate mathematical and statistical techniques, both theoretical and numerical, to concrete problems (Knowledge, Skill, Role in Context).

PLO 3 Present and communicate effectively mathematical knowledge and mathematical research (Autonomy & Responsibility).

PLO 4 Learn new mathematics independently (Skill, Autonomy & Responsibility, Self-development).