Department of Mathematics

College of Science

Salahaddin University -Erbil

Subject: Ring and Field Theory

Course Book – (PhD)

Lecturer's name Abdullah M. PhD

Academic Year: 2023/2024

Units: 3 (Second Semester)

Course Book

1. Course name	**Ring and field Theory**
2. Lecturer in charge	**Professor Dr. Abdullah M. Abdul-Jabbar**
3. Department/ College	**Mathematics / Science**
4. Contact	**e-mail:abdullah.abduljabbar@su.edu.krd** **e-mail:m1abdullah.math71@gmail.com**
5. Time (in hours) per week	**Theory: 3** **Practical: 0** **Tutorial:**
6. Office hours	**Availability of the lecturer to the student during the week**
7. Course code	
8. Teacher's academic profile	**i. BSc. (1992-1993)** **ii. M. Sc. (Topology) (2000)** **iii. Assistant Lecture (2000)** **iv. Lecture (2004)** **v. PhD. (Algebra) (2007)** **vi. Assistant Professor (2009)** **vii. Head of Mathematics in (Basic Education College) (2009-2010)** **viii. (46) Published paper about Algebra and General Topology.** **ix. Reviews at Mathematical Reviews in American Mathematical Society (USA) and Members of Editorial Board in (16) Journals outside Iraq.** **x. Professor (2019)**
9. Keywords	**Ring, Ideal, Subring, Quotient Ring, Homomorphism Ring**

10. Course overview:

In algebra, ring theory is the study of rings[1]—algebraic structures in which addition and multiplication are defined and have similar properties to those operations defined for the integers. Ring theory studies the structure of rings, their representations, or, in different language, modules, special classes of rings (group rings, division rings, universal enveloping algebras), as well as an array of properties that proved to be of interest both within the theory itself and for its applications, such as homological properties and polynomial identities.

In mathematics, and more specifically in ring theory, an ideal of a ring is a special subset of its elements. Ideals generalize certain subsets of the integers, such as the even numbers or the multiples of 3. Addition and subtraction of even numbers preserves evenness, and multiplying an even number by any integer (even or odd) results in an even number; these closure and absorption properties are the defining properties of an ideal. An ideal can be used to construct a quotient ring in a way similar to how, in group theory, a normal ubgroup can be used to construct a quotient group.

11. Course objective:

The objectives of this course are to:

1. Introduce students to the concepts of definition of rings, commutative rings, rings with identity with some examples.
2. Introduce students to the left (right) zero divisors, integral domain, subrings with some strong examples.
3. Introduce students to center of a ring with some properties, examples.
4. Introduce students to characteristic of a ring, some properties, examples, related with integral domain and finite integral domain.
5. Introduce students to the ideals and their operations.
6. Introduce students to the integral domain and fields and related between them.
7. Introduce students to the sum of ideals for finite and infinite with some properties, Internal direct sum with some properties, product of n ideals with some properties.
8. Introduce students to the right (left) quotient of two ideals with several properties and examples.
9. Introduce students to the homomorphism rings with First , Second and Third Isomorphism Ring Theorem.
10. Several others concepts about rings and ideals

12. Student's obligation

In this course, every lecture we review all topics with students which we gave in the previous lecture and when we teach, we try to contribute all students.

13. Forms of teaching

We use data-show with white board and give a copy of my lecture about On ring and field theory for all students step by step.

14. Assessment scheme

Your course grade will be determined as follows:

Midterm examination: 20%

Seminar: 5% (A part of seminar contains applications on group theory)

Quiz: 10%

Homework: 5%

Final Exam: 60%

15. Student learning outcome:

In first year in our Department of Mathematics, students studies Foundation of Mathematics, which included set theory. In this course we discuss ring and field theory which is applications of set theory step by step to understand them.

16. Course Reading List and References:

[1] McCoy N. H. and Berger T. R., Algebra: Groups, Rings and Other Topics, Allyn and Bacon, Inc. Boston London Sydney Toronto, 1977.
[2] Fraleigh J. B., A first Course in Abstract Algebra, ADDISON-WESLEY PUBLISHING COMPANY, 1982.
[3] Herstei I. N., Topics in Algebra, JOHN WILEY & SONS New York Chichester Brisbane Toronto Singapore, 1975.
[4] Allenby R B J T, Rings, Fields and Groups, Edward Arnold, 1983.
Dummit D. S. and Foote R. M., Abstrat Algebra, John Wiley & Sons, Inc., 2003.
[5] Singh S. and Zameeruddin Q., Modern Algebra, VIKAS PUBLISHING HOUSE PVT LTD, 1972.
[6] Gallian J. A., Contemporary Abstract Algebra, HOUGHTON MIFFLIN COMPANY, 1998.

17. The Topics:	Lecturer's name
Ring and Field Theory **1. Introduction to Rings** • Definition and Examples of Rings • Certain Elementary Theorems on Rings • Some Special Types of Rings (zero divisor, integral domain, unit) • Field Theory (Examples, Some properties of fields and especially related with an integral domain) • Division Ring (Properties, Examples, The Quoternions of Hamilton) • Characteristic of a Ring **2. Subring and Ideals** • Definition of Subring with Examples • Definition of Ideals with Examples • Properties of Subrings and Ideals	Non-Commutative Algebra (3 hours per week)

• The Sum of Two Ideals • The Multiplication of Two Ideals • Principal Ideals • Principal Ideal Ring • Simple Ring • Idempotent and Nilpotent Elements of a ring (Properties) • Boolean Ring with Some Properties • Centre of a Ring (Properties) • Radical Ideals (Properties) *3.* **Quotient and Homomorphism Rings** • Definition of Quotient Rings with Some Properties • Prime Ideals (Chracterizations, Properties, Examples) • Primary Ideals (Chracterizations, Properties, Examples) • Maximal Ideals (Chracterizations, Properties, Examples) • Homomorphism Ring with Examples • Endomorphism Ring with Example • Properties of Homomorphism Ring • Monomophism Mapping, Epimorphism Mapping, Isomprphism Mapping, Automorphism Mapping • Isomorphic Between Two Rings • Isomorphism Ring with Example • Kernel of a Homomorphism Ring, Examples, Some Properties • First Isomorphism Ring Theorem • Second Isomorphism Ring Theorem • Third Isomorphism Ring Theorem *4.* **Introduction to Polynomial Ring (Optional)** • Definition of Polynomial Rings • The Sum and Product of Two Polynomials • Leading Coefficient • Fundamental Theorem of Algebra • Some Properties of Polynomial Rings • Reducible and irreducible Polynomials	
18. Practical Topics (If there is any)	

19. Examinations:

Q;/ Define the sum of two ideals. Show that it satisfies all properties of rings.

Q:/ State and prove First Isomorphism Ring Theorem.

Q:/ State and prove Cayley Theorem.

2. True or false type of exams:

We use this type in exam.

3. Multiple choices:

We cannot use this type of exams.

20. Extra notes:

We apply seminar instead of assignments.

21. Peer review