Department of Mathematics

College of Science

Salahaddin University -Erbil

Subject: On Group Theory with Applications

Course Book – (PhD)

Lecturer's name Abdullah M. PhD

Academic Year: 2023/2024

Units: 2 (First Semester)

Course Book

1. Course name	**On Group Theory with Applications**
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: 2** **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	**group theory**

10. Course overview:

In abstract algebra, group theory studies the algebraic structures known as groups. The concept of a group is central to abstract algebra: other well-known algebraic structures, such as rings, fields, and vector spaces, can all be seen as groups endowed with additional operations and axioms. Groups recur throughout mathematics, and the methods of group theory have influenced many parts of algebra. Linear algebraic groups and Lie groups are two branches of group theory that have experienced advances and have become subject areas in their own right.

Various physical systems, such as crystals and the hydrogen atom, and three of the four known fundamental forces in the universe, may be modelled by symmetry groups. Thus group theory and the closely related representation theory have many important applications in physics, chemistry, and materials science. Group theory is also central

to public key cryptography.

11. Course objective:

1. Decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order

2. Express a given finite cyclic group as the direct product of cyclic groups of prime power order and, given two direct products of cyclic groups, determine whether or not they are isomorphic

3. Express products of elements of a group defined by generators and relations in appropriate standard form

4. describe inner automorphisms and their properties.

5. Extend group structure to finite permutation groups (Cayley's Theorem).

6. Prove and apply Sylow's Theorems.

7. Generate groups with given specific conditions.

8. investigate symmetry using group theory.

9. Other objectives.

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 group theory with applications for all students step by step.

14. Assessment scheme

Your course grade will be determined as follows:

Midtearm examination: 20%

Seminar: 10% (A part of seminar contains applications on group theory)

Quiz: 10%

Homework: 10%

Final Exam: 50%

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 on group theory with applications which is applications of set theory step by step to understand them.

16. Course Reading List and References:

1. Mark Reeder, Notes on Group Theory,
http://pdvpmtasgaon.edu.in/uploads/dptmaths/AnotesofGroupTheoryByMarkReeder.pdf

2. Durbin J. R., Modern Algebra, JOHN WILEY & SONS
New York Chichester Brisbane Toronto Singapore, 1985.

3. Dummit D. S. and Foote R. M., Abstrat Algebra, John Wiley & Sons, Inc., 2003.
4. Herstei I. N., Topics in Algebra, JOHN WILEY & SONS New York Chichester Brisbane Toronto Singapore, 1975.
5. McCoy N. H. and Berger T. R., Algebra: Groups, Rings and Other Topics, Allyn and Bacon, Inc. Boston London Sydney Toronto, 1977.
6. Allenby R B J T, Rings, Fields and Groups, Edward Arnold, 1983.
7. Fraleigh J. B., A first Course in Abstract Algebra, ADDISON-WESLEY PUBLISHING COMPANY, 1982.

17. The Topics:	Lecturer's name
On Group Theory with Applications **• Introduction to Groups** **• Some concepts of groups** **• Some concepts of subgroups** **• Some concepts of normal subgroup** **• Some concepts of quotient group** **• Some concepts of Homomorphism and Isomorphism group** **• Some concepts of p-groups and sylow theorems** **• Fiber of a function and the union of fibers**	Non-Commutative Algebra (3 hours per week)

• **Injective, surjective and bijective in fibers** • **Conjugation** • **Cosets and quotient spaces** • **Lagrange theorem with some corollary with examples** • **The first isomorphism theorem** • **Exact sequences and short exact sequences** • **The second isomorphism theorem (correspondence theorem)** • **The third isomorphism theorem** • **Normalizer** • **Direct products** • **Semidirect products (internal view)** • **Conjugacy** • **Conjugacy classes** • **Centralizer** • **The class equation** • **Cyclic decomposition and conjugacy classes** • **sigma-orbits** • **Disjoint cycle decomposition** • **The group Sn** • **Product of cycles** • **Descending decomposition** • **Length** • **Simple transpositions** • **Longest element** • **Inversions** • **Sign character and alternating group**	

• **Group actions** • **The left regular action** • **Group actions on coset spaces** • **Double cosets** • **Conjugation** • **Burnsides Lemma** • **Application: Graph counting** • **Linear groups** • **Symmetric groups and Linear groups** • **Conjugacy classes in GL2(F)**	
18. Practical Topics (If there is any)	

19. Examinations:

Q;/ Define the fiber of a function.
Q:/ State and prove cayley theorem.
Q:/ State and prove 5 properties of conjugation.

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:

Also we have some applications of general topology and combine it with biology and computer science such as digital topology, digital line and digital n space.

21. Peer review