Lahore University of Management Sciences

MATH 521 –Advanced Algebra

Fall 2023

Instructor	Imran Anwar, Spela Spenko, Peter Sevenhagen
Room No.	TBA
Office Hours	Tu 16:00-17:00 and Th 16:00-17:00
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Secretary/TA	No TA
Course URL (if any)	LMS website

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 min
Recitation/Lab (per week)	Nbr of Lec(s) Per Week		Duration	
Tutorial (per week)	Nbr of Lec(s) Per Week	1	Duration	75 min
Meeting Times			Location	

Course Distribution	
Core	MS, PhD
Elective	Seniors
Open for Student Category	Juniors, Seniors, MS, PhD Or instructor consent
Close for Student Category	None

COURSE DESCRIPTION

This course aims to develop the general theory of rings (especially commutative ones) and then study in some detail a new concept. That of a module over a ring. Both abelian groups and vector spaces may be viewed as modules and important structure theorems for both follow from the general theory. The theory of rings and modules is a key to many more advanced algebra courses e.g. Algebraic Number Theory and Commutative Algebra. It can also help with others, e.g. Galois Theory, Representation Theory and Algebraic Geometry.

COURSE PREREQUISITE(S)

MATH 320 Algebra 1 and upon the approval of Instructor

COURSE GOAL

The main aim is to give an overview of various topics in Advanced Algebra to prepare students for research in all fields.

Learning Outcomes

By the end of the course the student should have a more solid and sophisticated understanding of material covered in the Undergraduate curriculum, and also familiarity with topics that are not normally part of the undergraduate curriculum.

Grading Breakup and Policy (tentative)

Assignment(s): 20%
Midterm Examination: 30%
Final Examination:40 %
Semester Projects & Viva: 10%

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Examination Detail	
Midterm Exam	Yes/No: Yes
Final Exam	Yes/No: Yes Exam Specifications: Comprehensive

COURSE OVERVIEW

Week/ Lecture/ Module	Topics	Recommended Readings	Objectives/ Application
1-7	**Rings and Ideals** Rings, Ideals, Quotient Rings and Ring Homomorphism, Ring of Fractions, Euclidean Domains (EDs), Principal Ideal Domains (PIDs), Unique Factorization Domains (UFDs)	Chapter 7&8 [D]	
8-10	**The Polynomial ring** Definition and basic properties. Polynomial Rings over Fields. Polynomial Rings over Fields, Polynomial Rings that are Unique Factorization Domains, Irreducibility Criteria	Chapter 9 [D]	
11-14	**Modules** Introduction to Module Theory, Basic Definitions and Examples Quotient Modules and Module Homomorphisms, Generation of Modules, Direct Sums, and Free Modules, Length of Modules	Chapter 10 [D]	
15-22	**Exact Sequences ,Tensor Product** Tensor products of Modules, Exact Sequences, Projective, Injective, and Flat Modules	Chapter 10 [D]	
23-26	**Chain Conditions and Primary Decomposition** Localization, Noetherian, Artinrings , Associated Primes, Primary Decomposition	Lecture Notes	
27-28	**Further Topics** Graded rings and Modules, Monomial ideals, Square-free monomial ideas and Simplicial complexes	Lecture Notes	

Textbook(s)/Supplementary Readings

[D] David S. Dummit, Richard M. Foote. Abstract Algebra. 3rd ed. Hoboken, NJ: Wiley, 2004.
[L] Serge Lang, Algebra, Graduate Text in Mathematics, Springer, 2002.
[R] J. J. Rotman, A first course in Abstract Algebra, with Applications, 3rd edition, Pearson Prentice Hall, 2006.