

# KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

Department of Mathematics

MATH 654 (Advanced Topics in Algebra)

Semester 241 (Fall 2024)

Prof. Jawad Abuhlail

**Description:** Selected topics from: Groups, rings, modules, and general algebraic systems.

**Prerequisite:** MATH 551.

**Textbook:** J. Golan, *Semirings and their Applications*, Springer (2013).

<https://link-springer-com.kfupm.idm.oclc.org/book/10.1007/978-94-015-9333-5>

## Handouts:

**H1:** J. Abuhlail, *Exact Sequences of Commutative Monoids and Semimodules*, Homology, Homotopy and Applications 16 (1) (2014), 199–214.

**H2:** J. Abuhlail, *Some Remarks on Tensor Products and Flatness of Semimodules*, Semigroup Forum 88 (3) (2014), 732-738.

**H3:** J. Abuhlail and R. G. Noegraha, *On semisimple semirings*, Comm. Algebra. 49 (3), 1295-1313 (2021).

## Further References:

- 1) D. F. Anderson , T. Asir , A. Badawi and T. T. Chelvam, *Graphs from Rings*, Springer (2021).  
<https://link.springer.com/book/10.1007/978-3-030-88410-9>
- 2) M. Gondran and M. Minoux, *Graphs, Dioids and Semirings: New Models and Algorithms*, Springer (2008). <https://link.springer.com/book/10.1007/978-0-387-75450-5>
- 3) P. Grillet, *Abstract Algebra*, 2<sup>nd</sup> edition, Springer (2007).  
<https://link.springer.com/book/10.1007/978-0-387-71568-1>
- 4) R. Wisbauer, *Foundations of Module and Ring Theory*, Routledge, 1st edition (2018).  
<https://www.math.uni-duesseldorf.de/~wisbauer/book.pdf>

## Grading:

Midterm Exam	Assignment	Projects/Presentations	Poster	Final Exam
20%	15%	20%	15%	30%

## Exams:

	Midterm	Final
Date	13.10.2024	TBA

**Attendance:** Students are expected to attend all lecture classes.

- If a student misses a class, he/she is responsible for any announcement made in that class.
- A DN grade will be awarded to any student who accumulates more than 20% unexcused absences or 33% excused and unexcused absences

### Objectives:

- (1) To help students identify the main properties of semirings and semimodules.
- (2) To present the differences in the properties of rings (resp. modules) and their proofs and those of semirings (semimodules) and their proofs.

### Learning Outcomes:

Upon successful completion of this course, the student should be able to

Code	CLO
<b>1</b>	<b>Knowledge and Understanding</b>
1.1	Discuss basic examples of proper semirings that are not rings.
1.2	Explain similarities between proper semirings (resp. semimodules) and rings (resp. modules) as well as differences between them.
<b>2</b>	<b>Skills</b>
2.1	Prove and apply basic results on free, projective, and flat semimodules.
2.2	Prove and apply results on injective semimodules.
2.3	Prove and apply results on semisimple semirings, including structure results.
<b>3</b>	<b>Values</b>
	Manage complex ethical and professional issues and make informed judgements on ethical codes and practices.

## Detailed Syllabus

Week	Chapter	Title
1	1	Hemirings and semirings: definitions and examples
	3	Building new semirings from old
2	4	Some conditions on semirings
	5	Complemented elements in semirings
<b>September 22-23, 2024</b>		<b>National Day Holidays</b>
3	6	Ideals in semirings
	7	Prime and semiprime ideals in semirings
	8	Factor semirings
4	9	Morphisms of semirings
	10	Kernels of morphisms
5	13	Additively-regular semirings
6	14	Semimodules over semirings
	15	Factor semimodules
7	<b>Handout I</b>	Exact Sequences of semimodules
<b>October 13, 2024</b>		<b>Midterm Exam</b>
8	16	Some constructions for semimodules
9	<b>Handout II</b>	Flat Semimodules
<b>November 10-14, 2024</b>		<b>Midterm Break</b>
10 – 11	17	Free, projective, and injective semimodules
12	<b>Handout III</b>	Ideal-semisimple and Congruence-semisimple semirings
13-15	<b>Main Reference 1</b>	An introduction to graphs from semirings

### Projects:

	<b>I</b>	<b>II</b>	<b>Due</b>
<b>P1</b>	Limits	Colimits	2.9.2024
<b>P2</b>	Additively Idempotent Semirings	Subtractive Semirings	3.10.2024
<b>P3</b>	Weighted Anderson's Zero Divisor Graph	Weighted Beck's Zero Divisor Graph	21.11.2024