

Math 341 — Fall 2022

Modules and Rings I

<https://sites.aub.edu.lb/kmakdisi/>

Classes: MWF 2–2:50 in Bliss 206.

Professor: Kamal Khuri-Makdisi, Bliss 311, phone 4234. The best way to contact me is to send e-mail to kmakdisi@aub.edu.lb. My office hours are tentatively MW 3–5. You can also contact me by e-mail or through the discussion forum in Moodle.

Required textbooks: Jacobson, *Basic Algebra I and II*, W. H. Freeman or Dover. These two volumes are standard references and true classics. The treatment of modules over a PID in *Basic Algebra I* is my favorite source for this material. The book is available in the AUB bookstore.

Optional, but useful, supplementary textbooks:

- Dummit and Foote, *Abstract Algebra*, third edition, Wiley. The book covers undergraduate and graduate material starting from scratch, and goes well beyond Math 341. It is a good reference on basic algebra for any mathematician.
- Lang, *Algebra*, Graduate Texts in Mathematics, Springer. This is a very useful reference. You can download the book electronically from an AUB computer at the website <https://link.springer.com/book/10.1007/978-1-4613-0041-0>
- Hungerford, *Algebra*, Graduate Texts in Mathematics, Springer. Also electronic from AUB: <https://link.springer.com/book/10.1007/978-1-4612-6101-8>
- Knapp, *Basic Algebra* and *Advanced Algebra*, Birkhäuser, electronic from AUB: <https://link.springer.com/book/10.1007/978-0-8176-4529-8>
<https://link.springer.com/book/10.1007/978-0-8176-4613-4>

Course requirements: 50% weekly problem sets, 20% midterm, and 30% final. The problem sets will be challenging — it's the only way to really learn the mathematics. You may discuss homework problems with your classmates but you may not solve homework together. You must write your problem set in your own words, based on your own understanding of the solution. I encourage you to look up material in other books and articles, but if you use this resource in your solution of a problem, please give a reference to the text you used for each problem. **You MUST include in EACH problem set the names of any people you discussed the problem with, and full references to any books or websites you used in solving the problems.**

Prerequisites for this course: The formal prerequisites for this course are a good first semester of abstract algebra and a solid background in linear algebra. Beyond that, you should have the mathematical maturity expected for a graduate course. **If you haven't taken math graduate courses before**, be aware that the pace will be faster, and the problem sets more time-consuming, than in an undergraduate course. It is very important that you do your best to keep up with the course material and problem sets, as the subject matter takes some time to digest.

Topics covered: Depending on student background, I plan to cover the following topics, chosen mainly from Chapters 2 and 3 of Basic Algebra I, and Chapters 1 and 3 of Basic Algebra II. The precise list of topics is subject to change.

- Rings: the Euclidean algorithm in \mathbf{Z} and $F[x]$, principal ideal domains (PIDs), unique factorization, and the Chinese Remainder Theorem. (approximately 1 week, selections from BA I, Ch. 2)
- Introduction to Modules: basic definitions, diagram-chasing, direct sums, free modules. (approximately 2 weeks, BA I, 3.1–3.5)
- Structure theorem for finitely generated modules over a PID, with applications to linear algebra and abelian groups (approximately 4 weeks, BA I, 3.6–3.10)
- Basic notions of category theory (approximately 1 week, selections from BA II, Ch. 1)
- More thorough investigation of modules over arbitrary rings: Noetherian and Artinian modules, composition series, semisimplicity, tensor products, projective and injective modules (approximately 6 weeks, BA II, most of 3.1–3.11 with connections to Chapter 1 as needed)

Statement from the Accessible Education Office: AUB strives to make learning experiences as accessible as possible. If you anticipate or experience academic barriers due to a disability (including mental health, chronic or temporary medical conditions), please inform me immediately so that we can privately discuss options. In order to help establish reasonable accommodations and facilitate a smooth accommodations process, you must also register with the Accessible Education Office, West Hall 304, Extension 3168, accessibility@aub.edu.lb

Other AUB Policies: By signing up for this course, you confirm that you have read and accepted the terms and provisions of AUB's **Privacy Statement** and policies on **Academic Integrity** and **Non-Discrimination**.