אוניברסיטת
בן-גוריון בנגב

The Department of Mathematics

2021–22–B term

Course Name Commutative Algebra

Course Number 201.2.2011

Course web page
https://sites.google.com/view/amyekut-math-bgu/home/commutative-algebra-2021-22

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Office Hours https://www.math.bgu.ac.il/en/teaching/hours

Abstract

See Course Web Page[1] for details, including updated syllabus[2] and administrative information[3].

Requirements and grading[4]

[1]https://sites.google.com/view/amyekut-math-bgu/home/commutative-algebra-2021-22

[2]https://drive.google.com/file/d/16fVjxQhFgvAB-mPDlsc-G8Q9Jrhb6gOY/view?usp=sharing

[3]https://drive.google.com/file/d/1yzFjy3mMbXpZ-JWNYbmoCMlNaVDGvPSo/view?usp=sharing

[4]Information may change during the first two weeks of the term. Please consult the webpage for updates

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29 January 2022

Course Announcement:

Commutative Algebra

Spring Semester 2021-22

Catalog Number: 201.2.2011

Prerequities:

1. "Introduction to Commutative Algebra"
2. "Homological Algebra"

Recommended:

3. "Introduction to Algebraic Geometry"
4. "Basic Concepts in Topology and Geometry"

Practical Information. The course will be in English.

Format: Zoom software (possibly with student gathering in Room 201).
The first lecture will be on Wednesday 23 March 2022.

The course web page (with up-to-date information):

https://sites.google.com/view/amyekut-math-bgu/home/commutative-algebra-2021-22

Audience and Level. The course is intended for graduate students and advanced undergraduate students.

Participants of the course should have good knowledge of the prerequisite material.

Important: all the material from the course "Homological Algebra" from the Fall Semester is required! See the last published notes on course web page. The course will begin where the previous course ended.

Registration and Grading. There will be no exam, and the grade will be pass/fail. Participants are expected to attend all lectures (even if not registered). To pass the course, registered participants should attend all lectures, and submit most of the homework assignments.

The Zoom link will be sent through this list.

Course Topics: (As much as time permits. The first 4 topics are a continuation of the previous course. Later changes possible)

1. **Special modules.** Projective, injective and flat modules over commutative rings.
2. **Complexes of modules.** Operations on complexes, homotopies, the long exact cohomology sequence.
3. **Resolutions.** Projective, flat and injective resolutions.
4. **Left and right derived functors.** Special attention to Ext and Tor.
5. **Applications of homological algebra to commutative algebra**. Local and global criteria for projective modules. Regular rings via Koszul complexes (sketch). Cohen-Macaulay rings (sketch).
6. **Adic completion.** Inverse limits of rings and module. Comparison to metric completion. The noetherian case (flatness of completion). Relation to valuations. Hensel's Lemma and other applications.
7. **Differential Algebra.** Derivations, differential forms. Smooth and étale homomorphisms (sketch). Relations to Galois theory and differential geometry (sketch).

Bibliography:

1. P.J. Hilton and U. Stammbach, “A Course in Homological Algebra”, Springer, 1971.
2. S. Maclane, “Homology”, Springer, 1994.
3. J. Rotman, “An Introduction to Homological Algebra”, Academic Press, 1979.
4. L.R. Rowen, “Ring Theory” (Student Edition), Academic Press, 1991.
5. C. Weibel, “An introduction to homological algebra”, Cambridge Univ. Press, 1994.
6. A. Yekutieli, “Derived Categories”, Cambridge Univ. Press, 2019. Free prepublication version (on arxiv).
7. A. Altman and S. Kleiman, “A Term of Commutative Algebra”, free online.
8. H. Matsumura, “Commutative Ring Theory”, Cambridge Univ. Press, 1986.
9. D. Eisenbud, Commutative algebra, Springer, 1995.
10. Course notes, to be uploaded every week to the course web page.
11. Notes from the course Homological Algebra, Fall 2021-22.

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Course topics

Course Topics

1. Modules: free modules, exact sequences, tensor products, Hom modules, flatness.
2. Prime ideals and localization: local rings, Nakayama's Lemma, the spectrum of a ring, dimension and connectedness.
3. Noetherian rings: the Hilbert basis theorem, the Artin-Rees lemma, completion, grading.
4. Dimension theory: the Hilbert nullstellensatz, Noether normalization, transcendence degree.