

## The Department of Mathematics

2023–24–B term

**Course Name** Homological Algebra

**Course Number** 201.2.2091

**Course web page**

<https://sites.google.com/view/amyekut-math/home/teaching/homol-alg-2023-24>

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

### Abstract

### Requirements and grading<sup>1</sup>

### Course topics

- .1 Recalling prior material. Rings (including noncommutative), ideals, modules and bimodules, exact sequences, infinite direct sums and products, tensor products of modules and rings.
- .2 Categories and functors. Morphisms of functors, equivalences. Linear categories and linear functors. Exactness of functors.
- .3 Special modules. Projective, injective and flat modules.
- .4 Morita Theory. Equivalences of module categories realized as tensor products.
- .5 Complexes of modules. Operations on complexes, homotopies, the long exact cohomology sequence.
- .6 Resolutions. Projective, injective and flat resolutions – existence and uniqueness.
- .7 Left and right derived functors. The general theory. Tor and Ext functors.

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<sup>1</sup>Information may change during the first two weeks of the term. Please consult the webpage for updates

- .8 Applications to commutative algebra. Some local and global theorems, involving *Tor* and *Ext* functors. Derived completion and torsion functors.
- .9 Sheaf cohomology. A survey of the role of homological algebra in geometry.
- .10 Nonabelian cohomology. A survey of classification theorems: Galois cohomology, vector bundles.

### **Bibliography**

- .1 R. Hartshorne, "Algebraic Geometry", Springer-Verlag, New-York, .1977
- .2 P.J. Hilton and U. Stammbach, "A Course in Homological Algebra", Springer, .1971
- .3 S. MacLane, "Homology", Springer, .1994
- .4 J. Rotman, "An Introduction to Homological Algebra", Academic Press, .1979
- .5 L.R. Rowen, "Ring Theory" (Student Edition), Academic Press, .1991
- .6 C. Weibel, "An introduction to homological algebra", Cambridge Univ. Press, .1994
- .7 M. Kashiwara and P. Schapira, Sheaves on Manifolds, Springer, .1990
- .8 The Stacks Project<sup>2</sup>, an online reference, J.A. de Jong (Editor). (9) A. Yekutieli, "Derived Categories", Cambridge Univ. Press, .2019 Free prepublication version<sup>3</sup>. (10) Course notes, to be uploaded every week to the course web page

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<sup>2</sup><http://stacks.math.columbia.edu>

<sup>3</sup><https://arxiv.org/abs/1610.09640v4>