

## Mathematics 6321 (Fall 2019): Homological Algebra I

**Instructor:** Dmitri Pavlov, Assistant Professor

**Lectures:** TuTh 9:30–11, MA 113

**Credit hours:** 3

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**Office hours:** TuTh 2–3:30, MA 117C

### 1 Course Outline

This course will teach the basics of homological algebra, understood in the broadest possible sense, including homotopical algebra, sheaf cohomology, and other topics.

A classical array of topics will be covered, including the following: categories, simplicial sets, chain complexes, relative categories, derived functors, homotopical algebra, model categories, homotopy limits and colimits, spectra, sheaf cohomology, de Rham cohomology, Dolbeault cohomology, derived stacks.

The exposition will be heavily geometric, and connections to other areas of mathematics will be strongly emphasized, including, but not limited to, differential geometry, complex analysis, number theory, algebraic geometry, partial differential equations, and topology.

### 2 Catalog Course Description

Categories, functions, simplicial and singular homology, category of modules over a ring, resolutions, and derived categories.

### 3 Course Specific Expected Learning Outcomes

Upon completion of this course, students will be able to apply homological algebra to their area of research.

### 4 Assessment of Expected Learning Outcomes

Homework assignments will be given throughout the course. Two midterms and a final may be administered in class or as 4-hour take-home exams around September 26, October 31, and December 3 (tentative and subject to change or elimination).

### 5 Grading

The final grade depends on the homework, midterms, and final exam, if any of these were administered.

### 6 Text

The material will be drawn from a variety of sources, individual texts will be indicated as the course progresses.

Some recommended texts include the following:

Jacob Lurie: *Kerodon*

Denis-Charles Cisinski: *Higher categories and homotopical algebra*

Jacob Lurie: *Higher topos theory*

Jacob Lurie: *Higher algebra*

Emily Riehl: *Categorical Homotopy Theory*

William G. Dwyer, Philip. S. Hirschhorn, Daniel M. Kan, Jeffrey H. Smith: *Homotopy limit functors on model categories and homotopical categories*

Daniel Dugger: *A primer on homotopy colimits*

Sergei Gelfand, Yuri Manin: *Methods of homological algebra*

Charles A. Weibel: *An introduction to homological algebra*

## 7 Schedule

There will be 28 class meetings on the following days:

August 27:  
August 29:  
September 3:  
September 5:  
September 10:  
September 12:  
September 17:  
September 19:  
September 24:  
September 26:  
October 1:  
October 3:  
October 8:  
October 10:  
October 15:  
October 17:  
October 22:  
October 24:  
October 29:  
October 31:  
November 5:  
November 7:  
November 12:  
November 14:  
November 19:  
November 21:  
November 26:  
December 3:

## 8 Operating Policy 34.19: Student absence for observance of religious holy day

1. “Religious holy day” means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas Tax Code §11.20.
2. A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence.
3. A student who is excused under section 2 may not be penalized for the absence; however, the instructor may respond appropriately if the student fails to complete the assignment satisfactorily.

## 9 Operating Policy 34.22(2b): Reasonable accommodation for students with disabilities

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor’s office hours. Please note: instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, please contact Student Disability Services in West Hall or call 806-742-2405.

## **10 Operating Policy 34.12(5): Academic dishonesty definitions**

Students must understand the principles of academic integrity, and abide by them in all class and/or course work at the University. Academic Misconduct violations are outlined Part I, section B.1 of the Code of Student Conduct. If there are questions of interpretation of academic integrity policies or about what might constitute an academic integrity violation, students are responsible for seeking guidance from the faculty member teaching the course in question.

Academic misconduct includes cheating, plagiarism, collusion, falsifying academic records, misrepresenting facts, violations of published professional ethics/standards, and any act or attempted act designed to give unfair academic advantage to oneself or another student. Additional information about academic misconduct is available in the Texas Tech University Handbook in Part II, section B of the Community Policies section in the Student Handbook at <http://www.depts.ttu.edu/dos/handbook/>.