

MTG 7397: Advanced Topics in Topology 2

University of Florida, Department of Mathematics

Course Syllabus, Spring 2024

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Class meetings: MWF Period 6, 12:50–1:40pm, Little Hall Room 205

Textbooks.

- Category Theory in Context, by Emily Riehl. Available by download from Riehl's web page and there is a very inexpensive paperback edition.
- Homological Methods in Commutative Algebra, by Andrea Ferretti. Available from the UF Library via ProQuest.

Course description. In this course we will introduce some powerful mathematical tools whose origins lie in algebraic topology but which have been useful in many other areas and have become objects of study themselves. Specifically, we will learn about Category Theory, Homological Algebra, and Spectral Sequences. Each of these topics provides a formal framework for organizing mathematical structures and computations, and is an important tool in modern mathematics.

Course schedule.

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| Weeks 1–5 | Category Theory: categories, functors, natural transformations, universal properties, limits, colimits, adjoints, Kan extensions, localization, symmetric monoidal categories, enriched categories |
| Weeks 6–9 | Homological Algebra: abelian categories, chain complexes, additive functors, derived functors, Hom, Tensor, Ext, Tor, derived categories |
| Weeks 10–12 | Spectral Sequences: filtrations, bicomplexes, convergence, Grothendieck spectral sequence |
| Weeks 13–15 | Student Presentations: each student will give a presentation on a topic related to the course |

Course Objectives. Students will learn some advanced structures and tools from topology and how to apply them. Specifically, they will learn the main concepts in category theory, homological algebra, and spectral sequences, and how they may be used in various settings. In addition to learning some exciting mathematics, the course will be structured to aid the transition from being a student of mathematics to being a mathematician. Students will be expected to work individually and with classmates to digest the course material, work out examples, present their work, ask questions, and discuss mathematics.

Expectations.

- You will read relevant notes ahead of class and use available resources (classmates, textbooks, internet resources, the mathematical literature) to try to learn the necessary concepts.
- You will come to class with a list of concepts that you didn't fully understand and also questions that you have.
- You will be prepared to explain what you have learned.

Course work and assessment. The grading for the course will be based on written solutions to homework problems 50%, and one scheduled presentation to the class explaining a topic in the textbook that we did not cover 25% and accompanying written report 25%.

Grading scheme. A: 90% – 100%, A-: 85% – 89%, B+: 80% – 84%, B: 75% – 79%, B-: 70% – 74%, C+: 65% – 69%, C: 60% – 64%, D+: 57% – 59%, D: 54% – 56%, D-: 50% – 53%, E: 0% – 49%.

Additional Resources.

- (1) Wikipedia has good articles on many of the topics covered in this course.
- (2) An Introduction to Homological Algebra, Second Edition, by Joseph J. Rotman. Available from the UF library as an eBook download and also has a reasonably priced paperback edition.
- (3) An introduction to homological algebra, by Charles Weibel, is the standard reference book for the subject. The pdfs are available from the UF library.
- (4) Basic Category Theory, by Tom Leinster, is a great introduction to category theory and is freely available on the arXiv.
- (5) Abstract and Concrete Categories: The Joy of Cats, by Jiří Adámek, Horst Herrlich and George E. Strecker is available online and is a detailed introduction to category theory.
- (6) Categorical Homotopy Theory by Emily Riehl, further develops ideas from this course in homotopy theory. The pdf is available on the author's home page.
- (7) The nLab is a wiki for category theory and higher category theory. It is more advanced, but it's a great resource if you're willing to dive in.

Class demeanor. Students are expected to arrive to class on time and behave in a manner that is respectful to the instructor and to fellow students. Please avoid the use of cell phones and restrict eating to outside of the classroom. Other students should be respected in discussion.

Class attendance. Requirements for class attendance assignments, and other work in this course are consistent with university policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

Course evaluation. Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

Disabilities statement. Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Academic honesty. UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code.” On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor.

Grade points. More information on UF grading policy may be found at: <https://gradcatalog.ufl.edu/graduate/regulations/>

COVID-19. In response to COVID-19, the following recommendations are in place to maintain your learning environment, to enhance the safety of our in-classroom interactions, and to further the health and safety of ourselves, our neighbors, and our loved ones.

- If you are not vaccinated, get vaccinated. Vaccines are readily available and have been demonstrated to be safe and effective against the COVID-19 virus. Visit one.ufl.edu for screening / testing and vaccination opportunities.
- If you are sick, stay home. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 to be evaluated.
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work.

Campus resources.

Health and wellness.

- U Matter, We Care: If you or a friend is in distress, please contact umatter@ufl.edu or 352-392-1575 so that a team member can reach out to the student.
- Counseling and Wellness Center: Visit <https://counseling.ufl.edu> or call 352-392-1575 for information on crisis services as well as non-crisis services.
- Student Health Care Center: Call 352-392-1161 for 24/7 information to help you find the care you need, or visit <https://shcc.ufl.edu/>.
- University Police Department: Visit <https://police.ufl.edu/> or call 352-392-1111 (or 9-1-1 for emergencies).
- UF Health Shands Emergency Room / Trauma Center: For immediate medical care call 352-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608; <https://ufhealth.org/emergency-room-trauma-center>.
- GatorWell Health Promotion Services: For prevention services focused on optimal well-being, including Wellness Coaching for Academic Success, visit <https://gatorwell.ufsa.ufl.edu/> or call 352-273-4450.

Academic resources.

- E-learning technical support: Contact the UF Computing Help Desk at 352-392-4357 or via e-mail at helpdesk@ufl.edu.
- Career Connections Center: Reitz Union Suite 1300, 352-392-1601. Career assistance and counseling services <https://career.ufl.edu/>.
- Library Support: <https://cms.uflib.ufl.edu/ask> various ways to receive assistance with respect to using the libraries or finding resources.

- Academic Resources, 352-392-2010 or to make an appointment 352- 392-6420. General study skills and tutoring. <https://academicresources.clas.ufl.edu/>
- Writing Studio: 2215 Turlington Hall, 352-846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>
- Student Complaints On-Campus:
<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>