

640:541 Introduction to Algebraic Topology II

Spring 2022

TF2 10:20 - 11:40 am, Hill 005 on Tuesdays, zoom on Fridays

Instructor: Hongbin Sun

Email: hongbin.sun@rutgers.edu

Office hour: M 9:30 - 11:00 on zoom

Textbook: Allen Hatcher, Algebraic Topology
John Milnor & James Stasheff, Characteristic Classes

Prerequisites: Math 540 Introduction to Algebraic Topology I or equivalent

Course Description: This is a continuation course of Math 540 Introduction to Algebraic Topology I. Continuing the topic's in the previous semester, the following topics will be covered.

1. Homotopy theory. Homotopy theory studies homotopy classes of maps from spheres to topological spaces, which is a natural generalization of the fundamental group, while their behaviors are very different from each other. The topics we will cover include: Whitehead's theorem, cellular approximation, excision theorem, Hurewicz theorem, long exact sequence of fiber bundles, connections with cohomology, obstruction theory, Leray-Hirsch theorem and Gysin sequence, etc.
2. Characteristic classes. For any vector bundle over a nice topological space, a characteristic class associates this vector bundle with a cohomology class of the base space. Characteristic classes are very useful in differential topology and differential geometry. The topics we will cover include: basics on vector bundles, Grassman manifolds, universal bundles, Stiefel-Whitney classes, Euler classes, Chern classes, Pontrjagin classes, Chern numbers, Pontrjagin numbers, the oriented cobordism ring, etc.

Course meeting platform: We will do online meetings in January (the first two weeks of Spring 2022), and (hopefully) switch back to normal in February.

The original plan of this course is to do in-person meetings (at Hill 005) on Tuesdays, and do online meetings on Fridays. If students prefer in-person meetings and there is an available room, we can switch Friday lectures to in-person meetings starting from February.

We will use zoom as the online platform of this course, including one lecture (on Friday) and one office hour per week. In case of emergency, we will also have a zoom room for Tuesday. The zoom links of these three weekly (recurring) meetings are posted at the "announcement" of Canvas.

Course Website: The official course website is Canvas and all registered students have access to it. All course announcements and materials will be posted on Canvas.

Homework: Homework is due on Tuesdays of every two weeks, by the end of the lecture (11:40am), submitted either physically during the lecture or online (Canvas). No late homework will be collected.

The instructor will post homework problems on Canvas at least one week before the due date. We will withdraw the lowest homework grade.

Students can discuss with each other on homework problems, but should write his/her own solution. Directly copying solutions from online sources or printed solutions is prohibited.

Exams and grades: We will decide the style of the final exam after the semester starts. It will be either an oral exam, a take-home exam, or no exam. The homework grade will occupy at least 60% of the total grade, and the take home or oral final will occupy 40% of the total grade (if we have a final).

Academic integrity: All students in the course are expected to be familiar with and abide by the academic integrity policy (<http://academicintegrity.rutgers.edu/>). Violations of the policy are taken very seriously.

Special accommodations: Rutgers is fully committed to compliance with the Americans with Disabilities Act; policies and procedures are indicated at <https://ods.rutgers.edu/>.

Students who wish to request special accommodations must present a Letter of Accommodations to the instructor as early in the term as possible (<https://ods.rutgers.edu/my-accommodations/letter-of-accommodations>).

We will roughly follow the following schedule (may be subject to change). Here “H” refers to Hatcher’s Algebraic Topology, and “MS” refers to Milnor and Stasheff’s Characteristic Classes.

Week	Lecture dates	Sections	Topics
1	1/18, 1/21	H 4.1	Review, definition and properties of homotopy groups
2	1/25, 1/28	H 4.1	Whitehead's theorem, cellular approximation, CW approximation
3	2/1, 2/4	H 4.2	Excision of homotopy groups, the Hurewicz theorem
4	2/8, 2/11	H 4.2	The Hurewicz theorem, fiber bundles
5	2/15, 2/18	H 4.2, H 4.3	Fiber bundles, homotopy construction of cohomology
6	2/22, 2/25	H 4.3	Homotopy construction of cohomology, fibrations
7	3/1, 3/4	H 4.A, H 4.D	Basepoints and homotopy, Leray-Hirsch theorem
8	3/8, 3/11	H 4.D, MS 1-3	Gysin sequence, smooth manifolds and vector bundles
9	Spring break!		
10	3/22, 3/25	MS 5-7	Grassman manifolds and their cohomology, universal bundles
11	3/29, 4/1	MS 4, 8	Stiefel-Whitney Classes
12	4/5, 4/8	MS 9, 11	Euler Classes, Computation in smooth manifolds

13	4/12, 4/15	MS 13, 14	Complex Vector bundles, Chern classes
14	4/19, 4/22	MS 15-17	Pontrjagin classes and numbers, the oriented cobordism ring
15	4/26, 4/29	MS 18, 20	Thom spaces and exotic 7-sphere

STUDENT WELLNESS SERVICES:

Just In Case Web App

<http://codu.co/cee05e>

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS).

(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901 / www.rhscaps.rutgers.edu/.

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA)

(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / www.vpva.rutgers.edu/

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932- 1181.

Disability Services

(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / <https://ods.rutgers.edu/>.

Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation:

<https://ods.rutgers.edu/students/documentation-guidelines> If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at:

<https://ods.rutgers.edu/students/getting-registered>

Scarlet Listeners

(732) 247-5555 / <http://www.scarletlisteners.com/>.

Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.