MATH5665: Algebraic Topology
Course Outline

Lecturer/Tutor: A/Prof. Daniel Chan

E-Mail: *danielc@unsw.edu.au*

Webpage: web.maths.unsw.edu.au/∼danielch

Office: Red Centre (East Wing) Room 4104

Office Phone No.: 9385 7084

Consultation Hours: TBA (see webpage).

Most of the information you need to know about the course, including lecture notes can be gotten from the webpage above.

Lectures/Tutorials: There will be 3 hours of classes each week. There will be a tutorial every other week. All other classes will be lectures.

What you need to know to do this course

Ideal preparation for this course are MATH3611, MATH3711 and MATH3701. The last is helpful, but I will review some material about homotopy you would have learned there. You need to know abelian groups and isomorphism theorems well, and have good knowledge of point set topology. Despite the minimal pre-requisites, the course requires quite a bit of mathematical maturity.

About this course

Algebraic topology is about the study of topological spaces using algebraic invariants. In this course, we will mainly look at homology, which in some sense detects n-dimensional "holes" in a space. It will allow us not only to show that various spaces are non-homeomorphic (traditionally a hard thing), but prove other topological facts such as the fundamental theorem of algebra.

Assessment

The grade for this course will be determined from 2 short assignments (worth 17% each), tutorial participation (worth 6%) and a final exam (worth 60%). The assignments are meant to be relatively straightforward, once you have understood the material. The hard part is of course understanding the material. It is expected that most of you will be getting close to full marks in the assignments. That way, a "pass" in the final exam should get you a credit. If you are having trouble with the assignments, you should talk to other students and me about it. The most

important thing is that you learn the material.

In the tutorials, I would like all students to team up in pairs and pick questions from the problem sheets to tackle. Ideally, you can then present them in class, but if not, come chat with me so that you are at least learning throughout the semester.

The final exam will include questions of a more challenging nature and should distinguish the best students in the class.

Studying for this course

This course will be taught in a similar vein to your third year core pure maths courses, but is more demanding as the proofs are now more involved. Some theorems require several lectures to prove and a considerable amount of machinery. The concepts will take a while to digest so don't expect to understand everything in lectures. Try to get as much as possible out of them, and go over the material regularly after class. I suspect that filling in these gaps in understanding will take up a significant amount of your study for this course. If you are understanding very little of the lectures, then that's probably an indication that you haven't properly understood material in earlier lectures. I also strongly suggest you supplement your learning by browsing the references below.

There are some lecture notes I'll make available on my webpage. You can bring them to class and add detail and pictures as we progress through them. For many of you, it may be a good idea to skim the lecture notes before class.

There are few tutorials in this course, so you will be expected to do most of the exercises in your own time. This is to help prepare you for learning later in life, whether in academia or industry, where tutorials are rarely given.

Student learning outcomes

Mathematically, I hope you will see how many of the ideas in MATH3711 and MATH3611 come together. In particular, you will apply the concept of groups and group homomorphisms, to study topological spaces. There will be more abstract concepts which may take time to digest, but hopefully you will appreciate how they allow us to precisely describe and understand topological phenomena we see everyday, such as "Why is there a point on a coconut where the hairs emanate from?".

From a skills perspective, I hope you will develop your problem solving and analytical skills. The course should also help you improve your conceptual thinking. You should understand by now, that modern mathematics is communicated in a very different fashion to other disciplines and to everyday speech. Though it can be terse, it has great precision. I hope in this course, you will gain a greater appreciation of the modes of mathematical communication.

Tentative Syllabus

- Simplicial homology
- Categories and functors
- Topological applications of homology
- Singular homology
- Cohomology

References

The lectures will cover all the material that you need to know, but nevertheless, you will probably find it handy to supplement your studies by looking at texts such as those below. Most of the material from the course is standard and taken from Munkres's text below.

- Munkres, James R. Elements of algebraic topology. Vol. 2. Reading: Addison-Wesley, 1984.
- Spanier, Edwin H. Algebraic topology. Vol. 55. No. 1. Springer Science & Business Media, 1994.
- Hatcher, Allen. Algebraic topology. 2002. Cambridge UP, Cambridge 606.9.

Continual Course Improvement

The School of Mathematics evaluates each course each time it is run. Feedback on the course is gathered using, among other means, UNSW's Course and Teaching Evaluation and Improvement Process. Student feedback is taken seriously, and continual improvements are made to the course based in part on such feedback.

This time round, the course will involve more student participation with a flipped classroom in tutorials.

School of Mathematics and Statistics Student Policies

School of Mathematics and Statistics policy regarding tests, assignments additional assessment etc can be found at

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

The UNSW Plagiarism Policy is also there.

Daniel Chan