Math 470 Syllabus—Spring 2017
Topology, MW 2:30-4pm, Ford 301
Prof. Inga Johnson

What is Topology? The mathematical field of topology is often described as a modern version of geometry. The objects we will study in this class are similar to the shapes and spaces studied in a geometry class but the questions asked in topology are quite different. We won't look at questions pertaining to lengths and angles, instead we will study *properties* of geometric shapes *that remain* if the shape is changed continuously without ripping or puncturing. The concept of continuity is central in the field of topology.

As you may recall, continuity is a important characteristic and key hypothesis for many theorems in calculus. The course Real Analysis (Math 446 & 447) formalizes many of the concepts of calculus, in particular continuity, and there are many connections between Topology and Real Analysis. The area of study called *point set topology* generalizes the ideas of continuity and closeness even when a space has no notion of distance. We will study point set topology in Chapter 7 and see other connections to real analysis in Chapter 5. Topology also uses numerous ideas and structures from Abstract Algebra (Math 456 & 457). The subfield of topology called *algebraic topology* uses algebraic structures such as groups, vector spaces, and modules to distinguish between geometric shapes that have different topological structures. We will study the topic of homotopy, a concept within the area of algebraic topology, in Chapter 6, and (time permitting) at the end of the semester we will study another algebraic concept called homology.

There are many applications of topology to physics, chemistry, biology, engineering, statistics and data analysis. Topology can be used to study questions about string theory, the shape of space, robot motion, sensor networks, the weather, image recognition, DNA, molecular chirality, the shape of data, and even fixed point theorems in economics. Topology is a relatively young field of mathematics and many of its applications are the result of very recent innovations and research.

Course Goals: To understand introductory concepts, calculations and questions about topological invariants, classification of surfaces, three-dimensional manifolds, fixed points, homotopy theory, and point set topology. To increase proof writing ability, clarity, and sophistication. To increase ability to communicate mathematics verbally and in writing.

Office Hours:
Monday 4-5 p.m., Wednesday 11:30-12:30, Friday 1:30-2:30 or by appointment
Office: Ford 212
E-mail: `ijohnson@willamette.edu`

Course Textbook: *Topology NOW!* by Robert Messer & Philip Straffin.

Course Grades:

Weekly Homework:	28%
Midterm Exams:	30% (two exams 15% each)
Course Project & Presentation:	15%
Final Exam:	25%
Colloquium Attendance:	2%

Homework: There will be weekly homework assignments due on Friday. Homework for this course can either be submitted electronically on the WISE site by Friday at 4pm or you can submit a hardcopy of your assignment to me in my office on Friday by 4pm. The weekly homework assignments will be posted on the WISE site. Your homework must be written up using LaTeX. You may include figures in your homework by hand or by including .eps image files into your LaTeX document. It is my intention to return your homework within one week of the submission date, with the exception of late homework.

You may turn in ONE homework assignment late (within one week of when it was due) with no grade penalty. All late homework assignments should be clearly labeled with the phrase "Late Math 470 HW" at the top of the first page. Any late assignment turned in without this phrase might be lost, or confused with garbage and accidentally thrown out. Any additional late homework assignment that is turned in will be accepted and corrected at my discretion. Any homework that is turned in late may not be graded or returned until the end of the semester.

Midterm Exams and Final Exam: There will be two midterm exams and a final exam. Exams will be taken individually to test your concept understanding, mathematical literacy, and proof writing abilities over the topics covered thus far in the course. The final will be comprehensive.

Course Project: At the end of each chapter of the textbook there are suggested readings and possible topics for course projects. I will also be suggesting additional ideas for project topics throughout the semester. To help you select an appropriately challenging but focused project topic you must *submit a topic proposal by Monday, March 20.* Your project topic proposal should give a brief outline of your proposed topic of study and include a list of possible sources each with specified pages that contain work relating to your topic. Conversations with me about your project topic before this deadline are encouraged and I will give you feedback on your project proposal within the week. All project topics must be approved before Spring Break. Each student will **present a poster** on their course project during the week of April 24 in class. Additional details regarding the expectations and assessment of the course project will be posted on the WISE site.

Math Colloquium: You are encouraged to go to many of the Math Department Colloquia this semester to learn about the breadth of topics and questions studied in pure and applied mathematics. As part of this course you are required to attend four colloquiua. Attendance will be taken using a sign-in sheet at each colloquium talk. Cookies and tea will be provided and your courteous attention to the speaker is expected. If your schedule conflicts with all the Colloquia scheduled, please see me for an alternate reading and writing assignment. Most, but not all, Math Colloquia will be Thursday afternoons at 4-5pm.

Study Habits for Success: I recommend the following study habits to increase your likelihood of success in this class.

- Before a given class period skim the section of the textbook that will be covered. Look for big picture ideas, definitions that may seem complicated, important examples that you may want to ask about in class. Math textbooks are often more difficult to read than other texts. It is often necessary to read the mathematics several times before the ideas are clear. This skim should serve as your first pass at the material. A

slightly fuzzy picture of the material is OK at this point.

- During class you will see some of the material from the textbook for a second time and some new material that is not in the text. Please feel free to ask questions during class that relate to the material presented.
- After class, review your notes and reread the section of the textbook that was covered in class. This third pass of the material should solidify all important concepts.
- Work on the homework problems. Don't expect to be able to sit down and complete all the problems in an hour. Some of the problems will require repeated attempts before you find a solution. I highly recommend starting early and spending many short periods of time on the homework problems that stump you. Coming back to a problem multiple times, even if only for 20 minutes, often leads to deeper understanding and breakthroughs. Extended study sessions working on problems for hours and hours without breaks often leads to frustration, exhaustion and decreased ability for new problem-solving ideas or breakthroughs in understanding.
- If you still feel shaky with the material after these three passes and are unable to complete any of the homework problems, please come to see me in office hours as soon as possible. It is typical for most students to attend office hours once each week. If you have homework questions you are welcome to stop by for as little as 15 minutes or the entire office hour.

Diversity and Inclusion: Willamette University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. My goal is to create a learning environment that is equitable, inclusive and welcoming. If any aspects of the instruction or design of this course interfere with your inclusion or accurate assessment or achievement, please notify me as soon as possible.

Accessibility and Accommodations: Students with disabilities are encouraged to contact the Accessible Education Services office in Matthews 103 at 503-370-6737 or disbinfo@willamette.edu to discuss a range of options to removing barriers in the course, including accommodations. If you are entitled to any kind of accommodation (extra time, non-distracting environment, etc.) during quizzes/exams, please make the appropriate arrangements with me *three days before* the day of the quiz/exam in question. I will gladly make necessary accommodations.

Academic Honesty: In accordance with Willamette University CLA catalog: "Plagiarism and cheating are offenses against the integrity of the courses in which they occur and against the College community as a whole... Ignorance of what constitutes plagiarism shall not be considered a valid defense." For further information about the Willamette University academic honesty policy please refer to the CLA catalog.

It is appropriate and very helpful to have study groups for homework. Sharing ideas and approaches is a good way to learn. However, *all students must find their own phrasing and wording for the written homework.* Copied homework will earn a grade of zero for all parties involved. I will spend no time trying to figure out who copied from whom.

Tentative Schedule:

Week 1: Sections 1.1, 1.2, 1.3 Equivalence, Bijections, Continuous Functions

Week 2: Sections 1.3, 1.4 Continuous Functions, Topological Equivalence

Week 3: Section 1.5, 1.6 Topological Invariants, Ambient Isotopy

Week 4: Sections 3.1, 3.2, 3.3 Surfaces, Cut and Paste, Euler Characteristic

Week 5: Sections 3.4 Classification of Surfaces, 4.1 3D Manifolds EXAM 1

Week 6: Sections 4.2, 4.3 Shape of Space, Euler Characteristic, Glueing Polyhedra Solids, 5.1 Continuous Functions on Closed Bounded Intervals

Week 7: Sections 5.1, 5.2 Continuous Functions on Closed Bounded Intervals, Contraction Mapping Theorem

Week 8: Section 5.3, 5.4 Sperner's Lemma, Brower's Fixed Point Theorem

Week 9: Sections 6.1, 6.2, 6.3 Deformations with Singularities, Invariance of Fundamental Group

Week 10: Sections 6.4, 6.5, 6.6 The Sphere and the Circle, Words & Relations, The Poincare Conjecture EXAM 2

Spring Break

Week 11: Section 7.2, 7.3 Topological Spaces, Connectedness

Week 12: Sections 7.4, 7.5 Compactness, Quotient Spaces

Week 13: Section 7.5 Quotient Spaces, Simplicial & Cell Complexes

Week 14: Poster Presentations, Simplicial & Cellular Homology

Week 15: review

FINAL EXAM: Monday, May 8, 2017

Important Deadlines:

Last Day to Add/Drop, January 30, 2017

Last Day to choose Credit/No Credit, February 27, 2017

Last Day to Withdraw, March 15, 2017

Spring Break, March 27-31, 2017

Student Scholarship Recognition Day, April 19, 2017

Last Day of Classes, May 1, 2017