Math 3200-01: Introduction to Topology
TR 2:35–3:50pm in SC 1120
Spring 2016

Instructor: Prof. Spencer Dowdall

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Office Hours:
Tues 1:00–2:30pm
Wed 1:00–2:00pm
Thurs 11:30–12:00pm
and by appointment

Course Information

Description: The three main topics to be covered in this course are:

1. Point set topology (or the theory of abstract "spaces")
2. Knot theory
3. Surface theory

Point set topology forms the heart of the course. This concerns both the *local* and *global* structure of spaces and is, in a sense, a formalism that captures which points in a space are near each other. This formalism lays the foundation to discuss such fundamental notions as continuity, connectedness, and compactness. Point set topology is foundational material for many branches of mathematics, such as analysis and algebraic geometry, and it is needed to make the theory of knots and surfaces rigorous.

Knot theory is about loops of string in 3–dimensional space. Intuitively, such a loop may be "knotted" in various configurations or "unknotted." We'll make these notions precise and develop some machinery and modern polynomial invariants for studying and distinguishing knots. We'll quickly find ourselves at the frontiers of research thinking about unanswered questions.

Surface theory is about 2–dimensional manifolds: spheres, tori, Möbius strips, Klein bottles, etc. We'll discuss ways of constructing surfaces and, time permitting, prove a classification theorem that lets us distinguish one surface from another.

This course is highly recommended if you are mathematically talented and if any of the following describes you:

- you are considering graduate work in mathematics
- you are considering a research career in theoretical physics, chemistry, or biology and want an introduction to some modern mathematical tools
- you like geometric thinking and want to pursue that in a mathematically rigorous way
- you are an engineering student and want to see a side of mathematics different from routine calculus

Warning: This is a rigorous, proof-based mathematics course. You will be required to understand theorems and their proofs, and discover and write proofs on your own.

Prerequisites include completion of our calculus sequence and Linear Algebra (preferably Math 2300 and Math 2600, or Math 2500-2501). An additional proof-based course is recommended. You should know the basics of mathematical logic, sets, functions, and proofs.

Text: The required text for this course is:

Introduction to Topology, Third edition by Bert Mendelson.

We will cover most of the topics in this book. **Reading the textbook** is highly recommended. Some of the topics we will cover (e.g., knot theory) are beyond the scope of the textbook, but are addressed in the following **additional resources**:

- Notes on Topology, written by Professor Bruce Hughes. Available on our Blackboard page.
  These are notes from previous semesters of Math 3200 that Prof. Hughes has developed over time. They are not complete, but they contain a lot of good information tailored to this course.
- *Introduction to topology: pure and applied*, by Colin Adams and Robert Franzosa.
  On reserve at the Service Desk in the Science and Engineering Library.
  This covers basic topology as well as knot theory, surface theory, and other interesting applications.
- *Topology*, by James Munkres. Call number QA611 .M82 2000.
  This is a more advanced (graduate-level) text on point-set and algebraic topology

Course webpage: Access the course webpage by logging in to `https://blackboard.vanderbilt.edu`. View the webpage for course information (including this document) and content, announcements, homework assignments, the current schedule of topics, and grades for completed assignments. Some of this information is also available on my personal website at:
`www.math.vanderbilt.edu/~dowdalsd/Sp2016math3200/`

Grading: Final grades will be computed according to the following breakdown:
Homework–45%, Mid-term exam–25%, Final Exam–30%.

If you get above a 90/80/70/60 you are guaranteed to earn at least some sort of A/B/C/D. However, final grades may be curved so that the letter grade cut-offs are lower than this.

Midterm Exam: There will be a mid-term exam given in class on Tuesday **February, 16**. There may also be a take-home component to this exam.

Final Exam: There will be a comprehensive take-home final exam for the course. It will be distributed on the last day of class (Thursday, April 21) and is due by 2:00pm on **Monday, May 2**.

Homework: Homework assignments will be given in class and posted to the course webpage. Assignments will generally be due at the beginning of class on Thursdays. Solutions should be *neat*, *legible*, and *stapled*. Your **lowest homework score will be dropped**. Opportunities for class presentations of student solutions of some challenging problems will be given. Successful students will earn extra homework points.

I consider homework an essential part of this class. It is often said that the best way to learn mathematics is to do mathematics. To succeed in this class you should take the homework seriously and think carefully—and independently—about each problem. When the graded assignments are returned, you should read the grader's comments so that you are aware of and comprehend any mistakes in your solutions. You should also study the distributed solutions and be sure that you understand them.

Collaboration policy: Students are encouraged to work together on homework assignments. However, a student *should not present as their own work solutions to which they did not make substantial contribution*. Collaborators in a solution should be acknowledged.

Here is some clarification: It is okay to talk to each other about the homework and work out solutions together. But each student must *write up their solutions independently and in their own words*. It is not okay for one student to copy another student's write-up even if both students worked on the solution. In particular, it is not okay to share electronic files of solutions. Copying answers from another student or source, sharing electronic files, or allowing your answers to be copied will be considered a violation of Vanderbilt's Honor Code.

This policy is based on the fact that solving a mathematical problem has *two distinct parts*. The first is coming up with the intuitive ideas of why something works or is true. The second is being able to express those ideas in writing in a mathematically rigorous way. For beginning mathematicians, the *second part* is often the hardest. My goal is for you to become stronger at both parts.

Collaboration on the take-home components of the mid-term and final exams is **prohibited**.

Late homework policy: Assignments are due at the START of class on the due date. Assignments turned in at the END of class will receive **at most 50%** of the score otherwise obtained. Late homework will NOT be accepted without prior approval. Such approval will only be granted in extreme circumstances. If a student obtains permission to submit a late assignment, they may not consult with other students or with the distributed solutions.

Homework grading guide: As a general rule, a solution that could be made correct with minor editing will earn at least 5 points. A wrong solution will earn no more than 4 points. Here's a vague breakdown:

- 10pts – Perfect solution (except for minor typos); proofs are logical, complete, and efficient; terminology is properly understood; proofs have complete sentences, correct grammar, and read well (a good flow).
- 9pts – Small deviations from a 10 point solution.
- 8pts – Correct ideas, but contains a minor calculation mistake or a minor mistake in logic.
- 7pts – An 8 point solution, but there might be incomplete sentences or imprecise language.
- 6pts – A 7 point solution, but there might be some incorrect use of notation.
- 5pts – The essence is there, but is not communicated well.
- 4pts – Some correct intuition is present and the essence is understood.
- 3pts – The essence is missing, but there are some correct statements.
- 2pts – Shows correct understanding of the problem, but gets nowhere.
- 1pt – Misunderstood the problem or the solution is mostly unreadable.
- 0pts – The solution is completely wrong.

Attendance: Attendance is very important for this class; I strongly encourage you to actively participate by asking questions and engaging in class discussion. Attendance is expected for each class meeting, and students are responsible for all announcements, assignments, and material covered in class. See the College of Arts & Science policy on 'Class Attendance' in the Undergraduate Catalog.

Honor Code: Vanderbilt's Honor Code governs all work in this class. All work submitted for credit must be the student's own and should reflect the student's own understanding of the material. Here are some specific points to keep in mind:

- You may not consult homework solution handouts, tests, or test solution handouts from previous semesters. You man not consult the written homework of a student from a previous semester.
- You may not provide solutions to another student, nor obtain solutions from another student.
- You may not use the internet to obtain solutions.
- If you obtain my advance permission to submit an assignment after it is due, you may not consult with other students or the distributed solutions.

Accommodations: If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Equal Opportunity, Affirmative Action, and Disability Services Department (`www.vanderbilt.edu/ead/`). They will determine with you what accommodations are appropriate and communicate them to the instructor. This service is confidential.

Web Resources: The American Mathematical Society maintains a very useful page (`www.ams.org/outreach/undergrad.html`) for undergraduate mathematics majors that contains information on summer programs, graduate studies, clubs, undergraduate journals, competitions, careers, and much more.