COURSE DESCRIPTIONS (SPRING 2026)

The following courses are (tentatively) being offered for the Spring 2026 semester. Descriptions have been given by some instructors; more may be added over time. Note that slashlisted courses, quals courses, and topics courses have been collected separately in this document for your convenience.

Courses

(MATH 5103) Mathematical Models
Instructor: Alexander Grigo
Official Catalog Description: Prerequisite: permission of instructor or admission to the M.S. program. May be repeated with change of content; maximum credit six hours. Mathematical models are formulated for problems arising in various areas in which mathematics has been applied. In each case, techniques are developed for analyzing the resulting mathematical problem, and this analysis is used to test the validity of the model.

(MATH 5163) Partial Differential Equations
Instructor: Christian Remling
Official Catalog Description: Prerequisite: 4163 or permission of instructor. First order equations, Cauchy problem for higher order equations, second order equations with constant coefficients, linear hyperbolic equations.

(MATH 5183) Advanced Numerical Analysis II
Instructor: Ying Wang
Official Catalog Description: Prerequisite: 4433, 4443 or permission of instructor. Topics may include: analysis of spline approximations as a basis of the finite element method, error analysis for finite element approximation of elliptic and parabolic boundary value problems.

(MATH 5763) Intro to Stochastic Processes
Instructor: Nikola Petrov
Official Catalog Description: Prerequisite: 4733 or permission of instructor. Stochastic processes in discrete time including random walks, recurrent events, Markov chains and branching processes. Processes in continuous time including linear and nonlinear birth-death processes and diffusions. Applications taken from economics, engineering, operations research.

(MATH 6343) Lie Theory II
Instructor: Greg Muller
Description Provided by Instructor: This course will continue the where the previous semester (6333) left off. A rough goal is to finish Kirillov's *Introduction to Lie Groups and Lie Algebras*, specifically Chapters 5 through 8. This will include root systems, the classification of semisimple Lie algebras, the representation theory of semisimple Lie algebras, and the extension of these results to real and compact cases.

(MATH 6683) Differential Geometry II
Instructor: Justin Malestein
Official Catalog Description: Prerequisite: 6673. Riemannian manifolds, theory of connections, bundles with classical groups as structure groups, curvature and Betti numbers, complex manifolds.

Slashlisted Courses

These courses are offered simultaneously as undergraduate and graduate courses. Students enrolled in the graduate level may be expected to complete additional material.

(MATH 5373) Abstract Linear Algebra
Instructor: Keri Kornelson
Official Catalog Description: (Slashlisted with 4373) Prerequisite: 3333. Vector spaces over arbitrary fields, bases, dimension, linear transformations and matrices, similarity and its canonical forms (rational, Jordan), spectral theorem and diagonalization of quadratic forms. No student may earn credit for both 4373 and 5373.

(MATH 5383) Abstract Modern Algebra
Instructor: Roi DoCampo
Official Catalog Description: (Slashlisted with MATH 4383) Prerequisite: MATH 3333. Topics from the theory of error correcting codes, including Shannon's theorem, finite fields, families of linear codes such as Hamming, Golay, BCH, and Reed-Solomon codes. Other topics such as Goppa codes, group codes, and cryptography as time permits. No student may earn credit for both 4383 and 5383.

(MATH 5443) Introduction to Analysis II
Instructor: Javier Alejandro Chávez-Domínguez
Official Catalog Description: (Slashlisted with 4443) Prerequisite: 4433. Integration of functions of a single variable. Series of real numbers. Series of functions. Differentiation of functions of more than one variable. No student may earn credit for both 4443 and 5443.

(MATH 5743) Intro to Math Statistics
Instructor: Tomasz Przebinda
Official Catalog Description: (Slashlisted with 4743) Prerequisite: 4733. Mathematical development of basic concepts in statistics: estimation, hypothesis testing, sampling from normal and other populations; regression, goodness of fit. No student may earn credit for both 4743 and 5743.

Qualifying Exam Courses

These courses are the second halves of the three qualifying course sequences.

(MATH 5363) Abstract Algebra II
Instructor: Justin Malestein
Official Catalog Description: Prerequisite: 5353. Galois theory, solvability. Modules over a principal ideal domain. Noetherian ideal theory. Group representations, semisimple rings. Classical groups.

(MATH 5463) Real Analysis II
Instructor: Yilun (Allen) Wu
Official Catalog Description: Prerequisite: 5453. General measure and integration theory, Banach spaces, topics from related areas.

(MATH 5863) Topology II
Instructor: Max Forester
Official Catalog Description: Prerequisite: 5853. Metrization, product and quotient spaces, function spaces, dimension theory, Hilbert spaces, homotopy, simplicial complexes, continua.

Topics courses

Topics courses cover material at the discretion of the instructor. Two topics courses with the same name and number may cover significantly different material in different semesters. Topics courses may be repeated for credit; however, each course number has a limit on how many times it can be taken for credit.
Literacy courses are a special kind of topics course which are co-taught by three professors. Each professor teaches one-third of the semester on a topic of their choice.

(MATH 5263) Issues/Problems-Math Pedagogy
Instructor: Sepideh Stewart
Description Provided by Instructor: In this course, we will read and discuss a selection of classic mathematics education papers. For most students, this will introduce them to the field's scholarship, especially related to the teaching and learning of university mathematics. This course is intended for both mathematics and mathematics education students interested in foundational work in the field.

(MATH 5333) Topics in Number Theory
Instructor: Ameya Pitale
Description Provided by Instructor: **Introduction to Modular Forms**
In this course, I will give an introduction to the fascinating world of modular forms, one of the central objects in modern number theory. We will look at the motivation for studying these objects. In addition, we will consider the myriad of number theory applications ranging from formulas for representing integers as sums of squares to algebraicity of special values of L-functions. The course will involve working out details of examples and the applications so that the students will get a hands on experience. Prerequisites would be the knowledge from the qualifier algebra course. It will also be beneficial if you have taken a complex analysis course, or taking it concurrently.
For any student who is interested in number theory, this course is a must. For any student who wants to know if they could be interested in number theory, this course is a must. The only students who should not be enrolling in the course are those who unfortunately decided to lead a sad life devoid of number theory. Jokes apart, if you want to know whether the course is appropriate for you please feel free to get in touch with me.

(MATH 5803) Topics in Mathematics
Instructor: Michael Jablonski
Description Provided by Instructor: **Introduction to Representation Theory**
This class will serve as a first course in representation theory, the only prerequisite is the algebra qualifying class. The class will include content that most advanced graduate students will not have seen, so it will be useful for a broad cross-section of students.
We will start with Fulton and Harris's book "Representation Theory, A First Course" as a guiding text. Topics covered will include representations of finite groups, Schur's Lemma, complete reducibility, representations of compact and semi-simple Lie groups and Lie algebras (real and complex), and the classification of irreducible representations. We will introduce highest weight theory in the complex setting, its connection to Dynkin diagrams, and the relationship with irreducible representations in the real setting.
Other texts that will inspire the lectures include Onishchik's "Lectures on Real Semisimple Lie Algebras and Their Representations" and Humphrey's "Introduction to Lie Algebras and Representation Theory".

(MATH 6493) Topics in Analysis
Instructor: Yan Mary He
Description Provided by Instructor: I plan to teach quasiconformal maps and complex analytic aspects of Teichmuller spaces next semester in the topic course. In particular, I will mainly follow Chapters 4-6 of Hubbard's Vol 1.

The course is suitable for students who are interested in learning about Teichmuller spaces. It's good if students have seen hyperbolic geometry and Teichmuller spaces (from the geometric side), but it's not required as we will talk about another aspect of Teichmuller spaces. On the other hand, students should have passed the qualifying exams, which means they know basic topology (covering spaces etc) and analysis.

(MATH 6803) Literacy in Topology

Instructors: Peter Patzt, Murad Özaydın, Michael Jablonski

Description Provided by Patzt: **Hopf algebras**

We will give an introduction to Hopf algebras, Hopf modules, and their stucture theorems. We will focus on connected graded Hopf algebras over a field of characteristic, as their structure are particularly nice (basically free). In the end, we will go over some applications of the theory to algebraic topology.

The first part is very algebraic and elementary. For the applications in algebraic topology, some familiarity in homology and cohomology is encouraged.

Description Provided by Özaydın: **Magnitude and Path Homology**

Magnitude of a finite metric space (for instance a data cloud) was defined around 2011 (regarding the metric space as an enriched category) and soon generalized to the magnitude function and magnitude homology (as a categorification). Independently, path homology was defined (as a homotopy approach to digraphs, having many desirable properties like homotopy invariance and a Kunneth formula) and studied starting around 2012. Similarities between magnitude homology and path homology (as well as the concept of persistence in topological data analysis) was noticed a few years ago. Now there is a common framework for both and several generalizations. I plan to give a gentle introduction to these ideas.

The qual topology and algebra courses are hard prerequisites. Algebraic topology is not essential (simplicial complexes and the Euler characteristic will come up) but would be helpful to appreciate the material. The minimal category theory needed will be done in the lectures.

Description Provided by Jablonski: **deRham Cohomology**

I plan to give an introduction to manifolds and de Rham cohomology, as a tool for distinguishing between different manifolds. The expectation is that students have taken and passed the qualifying classes or exams. Major theorems/results to be discussed include: de Rham's theorem, Hodge's theorem, Stokes's theorem, Poincare duality, and Mayer-Vietoris sequences. Students will be introduced to differential forms. There will be (very light) homework given, with excessive hints included. The point of the homeworks is just to help you go through the motions of using the tools we discuss so that you can get a feel for them, see them at work, and gain a little familiarity.