Course descriptions, Fall 2024

The following courses are tentatively being offered for the Fall 2024 semester. Custom descriptions have been given by some instructors; more may be added over time.

MATH 5253 Intro to Mathematics Pedagogy Research
Instructor: Milos Savic

Goals: In this course, I want to give you an overview of RUME research, including teaching and learning theories, equity research, and research in specific mathematical topics (Calculus, Linear Algebra, Abstract Algebra, Proof, etc.). I would like to also discuss specific aspects of RUME research methods: qualitative and quantitative methods, literature review, theoretical framing, and research questioning.

Prerequisites: Graduate standing in mathematics or permission of the instructor.

Grade breakdown: the percentage breakdown is as follows:

- 40% Monday/Wednesday Discussion Boards
- 20% Two-pagers
- 20% RUME Research "Start" and Presentation
- 20% Final

MATH 5353 Abstract Algebra I
Instructor: Ameya Pitale

Course Catalog Description: Prerequisite: 4323, permission of instructor. Groups, Sylow theorems, group actions, group presentations. Rings, ideals, polynomial rings, unique factorization. Fields, algebraic and transcendental extensions.

MATH 4373/5373 Abstract Linear Algebra
Instructor: Alan Roche

Course Catalog Description: 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.

MATH 5423 Complex Analysis I
Instructor: Kimball Martin

Course Catalog Description: Prerequisite: 4433. The complex numbers, topologies of the extended plane and related sphere, elementary functions, power series, properties of general holomorphic functions. The integral of a complex-valued function over an oriented rectifiable curve, the classical theorems on integrals, Taylor and Laurent expansions, analytic continuation, introduction to Riemann surfaces.

MATH 5453 Real Analysis I
Instructor: Murad Özaydın

Course Catalog Description: Prerequisite: 4433 or permission of instructor. Lebesgue measure and integration theory, absolutely continuous functions, metric spaces.

MATH 4653/5653 Introduction to Differential Geometry I
Instructor: Roi Docampo

Course Catalog Description: Prerequisite: MATH 2443 or MATH 2934, and MATH 3333, or permission of instructor. Elementary theory of curves and surfaces in three-dimensional Euclidean space, differentiable manifolds, Riemannian geometry of two dimensions, Gauss Theorem Egregium.

MATH 4673/5673 Graph Theory I
Instructor: Ricardo Mendes

Description: This is an introductory course on properties and applications of graphs. We will study graph-theoretic concepts such as paths, Eulerian circuits, trees, distance, matchings, connectivity, network flows, colorings, planarity, and spanning cycles.

MATH 4773/5773 Applied Regression Analysis
Instructor: Wayne Stewart

Description: MATH 5773 applies linear algebra to multiple linear regression in order to obtain σ^2 and β estimates. The course starts with categorical variables and moves into hyper-plane column space theory to find interval and point estimates to linear models. While the course is theoretical it is also practical with substantial R development and application to many scientific problems.

MATH 5853 Topology I
Instructor: Yan Mary He

Course Catalog Description: Prerequisite: 2433 and 2513. Set theory, separation axioms, connectedness, compactness, continuity, metric spaces, nets and sequences.

MATH 6373 Commutative Algebra
Instructor: András Lőrincz

Course Catalog Description: Prerequisite: 4323, 4333, 5333 or permission of instructor. Commutative rings and their modelus, ideals, prime ideals, Noetherian modules and rings, localization, principal and factorial rings, discrete valuation domains, Dedekind domains, integral ring extensions, dimension theory, tensor products, flat modules, the homofunctor, injective and projective modules, regular rings, Cohen-Macauley rings.

MATH 5303 Homological Algebra (Topics in Group Theory)
Instructor: Greg Muller

Prerequisite: MATH 5363. Think of this course as MATH 6393 Topics in Algebra.
Description: Perhaps the most unexpected mathematical development of the 20th century was the emergence of homological algebra as a unifying framework for a wide variety of tools in topology, geometry, algebra, and analysis. Everything from Euler characteristic of polytopes to extensions of representations can be boiled down to questions about (co)homology groups. This class will develop the foundations of this unexpected but potent subject, starting with abelian categories and derived functors. The direction we end up going will depend on the students and their interests, but possibilities include topological (co)homology theories, sheaf cohomology, derived categories, and spectral sequences.

MATH 6473 Functional Analysis I
Instructor: Keri Kornelson

Course Catalog Description: Prerequisite: 5463 or permission of instructor. Vector spaces with topology or norm, dual space, theorems on linear operators, spectral theory in Hilbert space, spectral decomposition of operators, convex sets and weak topologies, fixed point theorems.

MATH 6493 Topics in Analysis (Literacy)
Instructors: Weinan Wang, Yan Mary He, Murad Özaydın

Descriptions: (1) Wang: PDEs and their applications in mathematical biology.

(2) He: Introduction to complex dynamics.

(3) Özaydın: C*-algebras, in particular Gelfand Naimark, Gelfand Naimark Segal, Stone Weierstrass theorems and graph C*-algebras.

MATH 6673 Differential Geometry I
Instructor: Justin Malestein

Course Catalog Description: Prerequisite: 5853 or permission of instructor. Multilinear algebra, differential manifolds, exterior differential forms, affine connections, Riemannian manifolds.

MATH 6813 Algebraic Topology I
Instructor: Nick Miller

Course Catalog Description: Prerequisite: 5863. Introduction to homology theory of spaces, fundamental group and covering spaces, higher homotopy groups, CW-complexes and cellular homology, Whitehead and Hurewicz theorems, Eilenberg-Steenrod axioms.

MATH 6833 Topics in Topology
Instructor: Michael Jablonski

Description: Topics class on homogeneous Einstein metrics.

Symmetry has long been a central tool in the study of geometry, with homogeneous spaces being a fertile playground for investigating the interactions between curvature, topology, and symmetry.

In the 1970's, it was conjectured that a non-compact, homogeneous space with non-zero, constant Ricci curvature should be diffeomorphic to $\mathbb{R}^n$. In 2023, the conjecture was proven by Boehm and Lafuente. This topics course will start from the basics of Riemannian geometry and homogeneous spaces, developing all the tools necessary to prove the conjecture. More precisely, we will study the geometry of solvmanifolds, geometric invariant theory over the reals, and cohomogeneity 1 actions in the non-compact setting. Along the way, we will highlight numerous open questions surrounding Ricci curvature in the presence of symmetry.

Students are expected to have seen the basics of Riemannian geometry.