UNIVERSITY OF WYOMING MATHEMATICS GRADUATE PROGRAMS

Math Department Graduate Coordinator

Beth Buskirk
email: bbuskirk@uwyo.edu
tel: 307.766.6546
fax: 307.766.6838
Ross Hall 203

Contents

Part A. **Graduate Programs, Setting, and Admissions**

1. Overview

The Mathematics Department at the University of Wyoming (UW) is a collection of friendly, easygoing people dedicated to excellence in mathematics. The math faculty at UW combine a passion for teaching with a deep commitment to research of the highest quality. The department takes great pride in the preparation its students receive for successful careers in the mathematical sciences; our graduates have prospered in a variety of academic, governmental, and industrial positions. Active research areas in the department include algebraic combinatorics; polyhedral and finite geometry; biological and geophysical modeling; complex analysis; elliptic curves and arithmetic geometry; linear algebra; mathematical and computational fluid mechanics; nonlinear partial differential equations; operator theory, numerical analysis; and stochastic analysis.

The department offers PhD, MS, and MST degrees. Our graduate program is designed to be flexible enough to meet students' individual interests while maintaining enough structure to guarantee graduate degrees of high quality. These degrees and their requirements reflect our belief that mathematicians should have a solid foundation in core areas of algebra, analysis, and applied mathematics, as well as the experience of a more intensive investigation and discovery in a specialization. Our program features intimate classes and lots of interaction with faculty. Virtually all of our graduate students are supported by teaching assistantships or research assistantships.

Think UW might be right for you? Contact us and tell us about yourself!

2. Laramie and the University of Wyoming

Nestled between two mountain ranges in southeastern Wyoming, UW offers varied academic and lifestyle opportunities including year-round cultural and recreational activities. UW is located in Laramie, a town of just more than 30,000 people with a unique blend of sophistication and western hospitality.

2.1. **About Laramie.** Laramie is located 49 miles from the state capital of Cheyenne and 130 miles from Denver, Colorado. Laramie sits 7,200 feet above sea level on the eastern edge of a large plateau called the Laramie Plains. UW students and visitors enjoy both a special blend of Laramie's western hospitality and the comfortable sophistication that comes from the influence of a major university.

USEFUL LINKS
City of Laramie: `www.ci.laramie.wy.us`
Chamber of Commerce: `www.laramie.org`
Albany County Tourism Board: `www.visitlaramie.org`

2.2. **About UW.** UW is Wyoming's only provider of baccalaureate and graduate education, research, and outreach services. UW combines major-university benefits and small-school advantages, with more than 180 programs of study, an outstanding faculty, and world-class

research facilities all set against the idyllic backdrop of southeastern Wyoming's rugged mountains and high plains. UW draws over 13,500 students from all 50 states and more than 90 countries.

USEFUL LINKS
University of Wyoming: www.uwyo.edu
Campus Map & Tour: www.uwyo.edu/uw/tour
UW Visitors Page: www.uwyo.edu/uw/aboutuw/

3. The Math Department

Although the numbers vary somewhat from year to year, the department is home to 24 research faculty, 7 permanent lecturers, 1-2 post-docs, and 25-30 graduate students. Frequent short- and long-term visitors from other departments enliven the mathematical life of the department, and a handful of part-time and adjunct faculty also contribute to our teaching mission. The department is housed in Ross Hall, at the center of the Laramie campus of UW.

3.1. **Recognition & Support.** In recent years, a number of our faculty have earned recognition for their research and educational activities. National recognitions include a prestigious *von Neumann Fellowship* (Institute for Advanced Study, 2014–15), a highly competitive *CAREER Award* (National Science Foundation, 2009–14), a *New Directions Professorship* (Institute for Mathematics and its Applications, 2008–9), and a *Centennial Fellowship* (American Mathematical Society, 2000). In addition, the UW math department boasts three winners (1994, 2005,2007) of the *Burton Jones Award for Distinguished Teaching of College and University Mathematics* awarded annually by the Mathematical Association of America—Rocky Mountain Section. At UW, the math department is home to multiple recipients (three winners since 1998) of the *George Duke Humphrey Award*—UW's highest award for faculty: in addition to acclaim as a teacher, winners must have achieved distinction as a scholar and have given distinguished service to the university. In addition, seven winners of UW's *Ellbogen Award for Meritorious Classroom Teaching*—a university-wide award—call UW math home.

Our various research, education, and outreach activities have been supported by the US National Science Foundation (NSF), the US Department of Energy (DoE), the National Aeronautics and Space Administration (NASA), the Air Force Office of Scientific Research (AFOSR), the Simons Foundation, the National Security Agency (NSA), and the UW School of Energy Resources.

3.2. **Research Centers & Affiliations.** One of the distinctive strengths of the UW math department is its broad portfolio of interdisciplinary research. UW math faculty have active and ongoing research collaborations with UW faculty in Electrical & Computer Engineering, Zoology & Physiology, Mechanical Engineering, Geology & Geophysics, Computer Science, and Civil Engineering, to name a few. Reflecting these collaborations, the UW math department has an diverse array of research connections across campus, in the Rocky Mountain region, and across the nation and world.

Institute for Scientific Computation: The Institute for Scientific Computation (ISC) is part of the math department at the UW. The ISC aims to provide support for campus research groups in scientific computation, including numerical modeling of physical and engineering problems, numerical analysis, and algorithm development. The ISC also serves as a resource for the training of undergraduate and graduate students in areas of applied mathematics and computing technology. The ISC has state-of-the-art computing resources to facilitate faculty and student research. Researchers have direct access to a Linux Cluster as well other unix-based computer equipment.

School of Energy Resources: UW has a long history of excellence in energy-related research, and the School of Energy Resources (SER)—formed in 2006—serves as an organizing center for UW's activities in energy-related education, research and outreach. SER directs and integrates cutting-edge energy research and academic programs at UW and bridges academics and industry through targeted outreach programs. Mathematics is a integral part of the SER program; two of our professors are *SER Professors* and a number of other faculty have research interests that connect with SER initiatives. For example, the director of the *Center for Fundamentals of Subsurface Flow*, a research center housed in SER, has a partial appointment as a math professor.

Program in Ecology: UW's Program in Ecology (PiE), is an interdisciplinary graduate program that draws faculty from a number of colleges. The research interests of participating faculty span a broad range of organisms, environments, analytical tools, and spatial and temporal scales; this research includes mathematical modeling and analysis. One of the math department's professors is on the PiE faculty.

Rocky Mountain Mathematics Consortium: UW is a long-standing member of the *Rocky Mountain Mathematics Consortium* (RMMC), a confederation of universities in the mountain west. The RMMC publishes the well-known *Rocky Mountain Mathematics Journal*, as well as the *Journal of Integral Equations and Applications* and the *Journal of Commutative Algebra*. In addition, an enduring tradition of this organization is an annual graduate-level summer school program at UW. These summer schools bring renowned mathematicians from around the world to Laramie and attract graduate students from across the western United States and beyond. Recent summer schools have focused on the following mathematical topics.

- *Stochastic equations for complex systems: theory & applications* (2014),
- *Algebraic graph theory* (2013),
- *Mathematical modeling in ecology & epidemiology* (2012),
- *Polyhedral geometry & algebraic combinatorics* (2011), and
- *Conservation laws & applications* (2010).

National Center for Atmospheric Research: UW is a member of the University Corporation for Atmospheric Research, a nonprofit consortium of more than 75 universities offering PhDs in the atmospheric and related sciences. UCAR manages the

National Center for Atmospheric Research (NCAR), headquartered in nearby Boulder, Colorado. NCAR is the nation's premier center for research in meteorology, climate science, atmospheric chemistry, solar-terrestrial interactions, environmental and related societal impacts. UW Math has a strong connection to NCAR through its *Institute for Mathematics Applied to Geosciences* (IMAGe) and the recent development of the NCAR-Wyoming supercomputer center in Cheyenne, Wyoming.

Institute for Mathematics and its Applications: The *Institute for Mathematics and it Applications* (IMA) is research institute funded by the National Science Foundation; the institute sponsors a variety of thematic programs, conferences, short courses, and "hot topics" workshops. The IMA is physically located on the campus of the University of Minnesota in Minneapolis, Minnesota. UW is an *IMA Participating Institution*, and this means that UW graduate students have special funding and access opportunities for IMA programs, either in Minneapolis or on the campuses of other participating institutions.

AMS, MAA, SIAM, AWM: The math department at UW is an institutional member of the American Mathematical Society, the Society for Industrial and Applied Mathematics, the Mathematical Association of America, and the Association for Women in Mathematics. UW Math hosted a regional MAA conference in Laramie in the spring of 2014.

3.3. **Facilities.** The math department is located in Ross Hall (a one-time women's dormitory named for the first female governor in United States) in the center of UW's main Laramie campus. Graduate students typically share offices in Ross Hall, and most of these offices are intermingled with the faculty offices. Ross Hall is also home to a lounge, classroom, conference room, and computational classroom all reserved solely for department use. In addition, Ross Hall houses a math tutoring center (the *Math Lab*) for undergraduates, and the university runs a newly refurbished food court (coffee shop, deli, salad bar, taco stand) on the ground level. UW libraries provide world-class library resources to faculty and students in the math department; virtually all journals are accessible online, the library will electronically deliver scans of older articles through their "Request it" service. Rare items not on the UW campus may be obtained quickly through the interlibrary loan program and/or the prospector network—a coalition of libraries across the front range of Colorado and Wyoming. High power computational facilities are available on campus through *Mount Moran* (an approximately 90 TFLOPS high performance cluster for modeling, data analysis and data-mover nodes, a shared pool of 350TB of network attached high performance disks), housed on campus, and through UW's partnership with the NCAR–Wyoming Supercomputing Center.

3.4. **Seminars & Colloquia.** The department hosts frequent lectures by local and visiting mathematicians. Regular seminars in the department include the following.

- Algebra, Combinatorics, & Number Theory
- Analysis/Applied Math
- Grad Student Seminar
- Colloquium

UW Mathematics Colloquia are intended to showcase recent mathematical developments of broad interest. These talks are aimed at the whole department, and graduate students are encouraged and expected to participate in these lectures and to interact with the visitors. Since 2005, UW's math colloquium has hosted a long list of distinguished mathematical visitors from many, many institutions including New York University, UC-Davis, UC-San Diego, UC-Santa Barbara, the University of Utah (Salt Lake City), Notre Dame (South Bend), William & Mary (Williamsburg), the University of Arizona (Tucson), Indiana University (Bloomington), the University of Michigan (Ann Arbor), the University of Illinois (Urbana–Champaign), the University of Wisconsin (Madison), North Carolina State University (Raleigh), the University of North Carolina (Chapel Hill), Carnegie Mellon University (Pittsburgh), the University of Colorado (Boulder), the University of Missouri (Columbia), Texas A&M University (College Station), Penn State University (State College), Oregon State University (Corvallis), Arizona State University (Tempe), Southern Methodist University (Dallas), Washington State University (Pullman), Colorado State University (Fort Collins), and the Colorado School of Mines (Golden).

UW faculty and students also participate regularly in a pair of regional seminars.

- Rocky Mountain Algebraic Combinatorics Seminar (4–6pm, alternating Fridays, at Colorado State University in Fort Collins, Colorado.)
- Front Range Algebra, GeoMEtry and Number Theory (FRAGMENT) Seminar. The FRAGMENT seminar meets either at the University of Colorado at Boulder (typically Tuesdays, 3–5pm) or at Colorado State University (typically Thursdays, 3–5pm).

USEFUL LINKS

Institute for Mathematics & its Applications: http://www.ima.umn.edu

NCAR–Wyoming Supercomputing Center: https://nwsc.ucar.edu/

4. Admissions

4.1. **Basic Requirements.** The GRE General Exam is required, with a minimum Quantitative Reasoning Score of 155 for master's applicants and 157 for Ph.D. applicants. The Verbal Reasoning Score is also given high consideration but does not have a minimum. The GRE may be waived with permission of the math graduate committee if the applicant has an MS or PhD from an approved institution. However, some research assistantships require the GRE of all applicants.

4.2. **International Applicants.** International applicants are required to take the TOEFL exam and earn a minimum score 76 on the iBT. The TOEFL requirement may be waived if a student comes from an English speaking country or has earned a degree from an accredited institution with instruction in English within a year of applying. ETS reports only TOEFL scores taken within two years of date of request.

4.3. **MST Program.** Applicants for the MST program are required to have:

- Valid teaching endorsement in any state, or educational requirements satisfied for secondary teaching.

- Two years' teaching experience at the pre-college level (may be completed during degree program).
- Courses equivalent to MATH 3000 or 3200, 3500 or 3550, 4000, and 4600. Students who enter with a deficiency in these courses must take them at UW but cannot count them towards the degree.
- A course in computer programming.

Part B. **Research & Degree Programs**

5. Research Themes

For administrative purposes, the department is structured into three research groups. However, these divisions can be somewhat artificial as faculty interests often stretch across several interconnected subdisciplines of mathematics.

5.1. **Algebra, Combinatorics, & Number Theory.** A major thrust of the research in the ACNT group at UW is in aspects of algebraic combinatorics. This branch of mathematics focuses on the interplay between algebra and combinatorics. Mathematical activity on this boundary between disciplines can be quite fruitful as algebraic techniques can sometimes shed new light on combinatorial problems and, conversely, techniques from combinatorics can be used to attack problems in abstract algebra. Finite geometry and graph theory provide a rich variety of problems in which this interplay is explored. Additional research interests in the group include matrix theory, elliptic curves & arithmetic geometry, convex geometry, and representation theory.

Faculty: Hall, Hobart, McAllister, Moorhouse, B. Shader, C. Shader, Williford

5.2. **Analysis.** The research interests of the analysis group touch a fairly broad range of both pure and applied mathematical topics. Nonlinear partial differential equations are a focal point of several group members' research. Many physical phenomena (e.g., the dynamics of fluids) generate systems of nonlinear partial differential equations as models, and a careful mathematical study of these model equations often begins with specialized tools built from a foundation of real, complex, and functional analysis. The group also boasts expertise in other aspects of functional analysis, in particular, in operator theory and operator algebras. Additional research in the analysis group includes elements of harmonic analysis, control theory, probability & stochastic differential equations, and several complex variables.

Faculty: Bessaih, Jafari, Lyng, Niu, Polyakov

5.3. **Computational & Applied Mathematics.** A majority of the UW faculty in our Computational & Applied Mathematics group focus their work around the use of modern computing technology to attack substantial problems in engineering and the sciences. Scientific computing is now a well-established pillar of modern scientific inquiry (alongside experimentation and theory), and members of our group both participate directly in these inquiries and also work to develop and understand the underlying mathematical basis for the algorithms that form the foundation of the discipline. In concert with these computational activities, the group also

develops and works to validate mathematical models for diverse physical and biological phenomena. Additionally, members of this group have expertise in nonlinear dynamical systems, nonlinear partial differential equations, and modern asymptotic and probabilistic methods.

Faculty: Allen, Douglas, Furtado, Ginting, Heinz, Lee, Liu, Pereira, Stanescu, Yeung

6. Outline of Program Requirements

The sections below give an incomplete overview of the program requirements; a detailed description of the official requirements is contained in the University of Wyoming Bulletin.

6.1. **MS/PhD.** The MS & PhD programs both start with the same basic requirements—a suite of six required *core courses* and a written exam, called the *foundation exam*. The core courses (two each in the areas of algebra, analysis, and computational & applied mathematics) form a broad foundation for future coursework and research in the program. The foundation exam, taken during the first year, is based on undergraduate-level linear algebra and advanced calculus; it is meant to ensure that all entering students have an appropriate preparation for graduate-level coursework.

6.1.1. *MS.* UW's math MS program requires 30 hours of graduate-level coursework with a cumulative GPA of at least 3.0. To accommodate the needs of different students, the department offers both thesis and non-thesis options.

6.1.2. *PhD.* Our PhD program requires 72 hours of coursework and dissertation research with a cumulative GPA of at least 3.0. At most 12 hours can be at the 4000 level, and at least 42 hours must come from formal 5000-level courses. For advanced graduate students, the department regularly offers special *topics courses* meant to expose students to active faculty research or to provide a forum for faculty and students to explore mathematical topics of mutual interest. A list of recent topics courses is given below.

Fall 2014: 5290: Introduction to Stochastic Processes (Bessaih), 5490: Mathematical Biology (Liu), 5700: Topics in Combinatorics (Williford)

Spring 2014: 5590: Elliptic Curves (Hall), 5490: Dynamic Big Data Driven Application Systems (Douglas)

Fall 2013: 5290: Stability of Nonlinear Waves (Lyng), 5490: The Finite Element Method (Ginting), 5590: Lie Algebras (C. Shader)

Summer 2013: 5700: RMMC–Algebraic Graph Theory (Williford)

Spring 2013: 5490: Principles of Stochastic Modeling (Heinz), 5490: Porous Media Flow (Pereira), 5590: Information Theory (Moorhouse)

Fall 2012: 5490: Continuum Mechanics (Allen), 5490: Iterative Techniques (Ginting)

Summer 2012: 5490: RMMC–Applied Math (Liu)

Spring 2012: 5700: Algebraic Graph Theory (Hobart), 5490: E**X**treme Technical Computing (Douglas)

In addition to coursework requirements, PhD students in the department must complete a research tools requirement (e.g., reading knowledge of a foreign language in which there is a large mathematical literature) and pass

(i) a written qualifying exam covering the material from the core course pair corresponding to the intended area of specialization, and
(ii) an oral preliminary exam focusing on the specialized mathematical material supporting the dissertation plan.

The most important part of the PhD program is the dissertation; the dissertation, completed under the close supervision of a faculty advisor, distinguishes the PhD from other degrees. Students who earn this degree have demonstrated a comprehensive understanding of a large body of mathematics **and** a substantial measure of mathematical creativity. A list of recent graduates and their dissertation titles can be found in §7.4 below.

6.2. **MST.** This degree is intended for in-service high school or middle school math teachers[1]. Candidates for the MST degree must complete at least 30 hours of coursework at the 4000 level or above, of which at least 18 hours must be math courses. A GPA of 3.0 in math courses is required. The program culminates with the preparation and defense of a thesis.

7. Department Personnel

All offices are in Ross Hall (RH), email addresses are (unless otherwise noted) `@uwyo.edu`, and phone numbers given as 6-*xyzw* may be reached from off-campus by dialing +1 (307) 766-*xyzw*.

7.1. **Research Faculty.**

Myron Allen (PhD, Princeton University, 1983)
Professor
Research Interests: Numerical analysis, mathematical modeling
RH228, 6-4286, `allen`

Myron Allen's mathematical interests include numerical analysis, mathematical modeling, and fluid mechanics in porous media. Applications of these areas include the analysis and prediction of contaminant flows in groundwater aquifers and flows of native and injected fluids in oil and gas reservoirs.

Hakima Bessaih (PhD, Scuola Normale Superiore di Pisa, 1999)
Associate Professor
Research Interests: Partial differential equations, probability theory and stochastic processes
RH210, 6-6213, `bessaih`

Hakima Bessaih's research interests include stochastic partial differential equations with applications in fluid mechanics, random dynamical systems, and more broadly, stochastic processes. Most recently, she has focused on the qualitative behavior of some Navier–Stokes and Euler-type PDEs driven by noise.

[1]The MSNS (Master of Science in Natural Science) Math option, through the Science and Math Teaching Center of the College of Education, is an alternative for middle school teachers.

Michelle Chamberlin (PhD, Purdue University, 2002)
Associate Professor
Research Interests: Mathematics education
RH221, 6-4017, `mchambe5`

Michelle Chamberlin's research in mathematics teacher education examines ways to enhance the effectiveness of mathematics and educational learning experiences of prospective and practicing teachers.

Craig Douglas (PhD, Yale University, 1982)
SER Professor
Research Interests: Numerical analysis
RH 227, 6-6580, `cdougla6`

Craig Douglas's research interests include eXtreme Technical Computing on parallel supercomputers and GP-GPUs, dynamic interactions between physical models, computation, and networks of sensors. He is an expert on multigrid methods and other numerical methods for solving partial differential equations.

Frederico Furtado (PhD, New York University, 1989)
Associate Professor
Research Interests: Partial differential equations
RH319, 6-4321, `furtado`

Fred Furtado's research focuses on nonlinear partial differential equations and fluid mechanics. In particular, he is interested in numerical and analytical approaches to study multi-phase flow problems.

Victor Ginting (PhD, Texas A&M University, 2004)
Associate Professor
Research Interests: Numerical Analysis
RH310, 6-4018, `vginting`

Victor Ginting's current research interest is in the mathematical and numerical aspects of multiscale phenomena as found in many applications, such as porous media flow.

Christopher Hall (PhD, Princeton University, 2003)
Associate Professor
Research Interests: Number theory and arithmetic geometry
RH 312, 6-4242, `chall14`

Chris Hall's primary research is in the field of arithmetic geometry. His interests include elliptic curves, abelian varieties, big monodromy, and compatible systems.

Stefan Heinz (PhD, Heinrich-Hertz Institute, 1990)
Professor
Research Interests: Mathematical modeling
RH214, 6-4203, `heinz`

Stefan Heinz has research interests in mathematical modeling, multiscale processes, stochastic analysis, Monte Carlo simulations, computational fluid dynamics, turbulence, combustion, and multiphase flows.

Sylvia Hobart (PhD, University of Michigan, 1987)
Associate Professor
Research Interests: Algebra and combinatorics
RH322, 6-4159, `sahobart`

Sylvia Hobart is interested in connections between algebra and combinatorics, especially in the context of coherent configurations and association schemes. She is particularly interested in the theory and applications of coherent configurations, quasi-symmetric designs, 2-designs with three intersection sizes, generalized quadrangles, and directed strongly regular graphs.

Lynne Ipiña (PhD, New York University, 1986)
Associate Professor
Research Interests: Mathematics education
RH320, 6-2318, `ipina`

Lynne Ipiña is best known for her work in mathematics education. Her early participation in the national debate about calculus, especially as it involves writing and appropriate uses of technology, has evolved into an interest in graphical representation.

Farhad Jafari (PhD, University of Wisconsin, 1989)
Professor & Head
Research Interests: Operator theory
RH229, 6-2383, `fjafari`

Farhad Jafari's mathematical interests include functional analysis and operator theory, semigroup theory, harmonic analysis, moment problems, and control theory. He is particularly interested in problems arising from mathematical physics.

Long Lee (PhD, University of Washington, 2002)
Associate Professor
Research Interests: Numerical analysis, mathematical modeling
RH212, 6-4368, `llee`

Long Lee's research interests span many areas, including numerical analysis, computational fluid dynamics, and numerical methods for nonlinear partial differential equations. Recently, his research interests have extended to inverse problems in seismology and geophysical flows.

Rongsong Liu (PhD, York University, 2006)
Assistant Professor
Research Interests: Dynamical systems, mathematical biology
RH217, 6-3395, `rliu1`

Rongsong Liu's interests are mathematical biology, differential equations, dynamical systems, and their interface. Her research projects involve formulation, analysis and applications of deterministic mathematical models for infectious diseases, and ecological systems.

Gregory Lyng (PhD, Indiana University, 2002)
Associate Professor
Research Interests: Partial differential equations
RH230, 6-3351, `glyng`

Gregory Lyng's mathematical interests are primarily in partial differential equations. He is especially interested in the existence & stability of traveling waves, Evans-function techniques, conservation & balance laws, gas dynamics, and shock waves.

Tyrrell McAllister (PhD, University of California–Davis, 2004)
Assistant Professor
Research Interests: Discrete and polyhedral geometry, representation theory
RH317, 6-5359, `tmcallis`

Tyrrell McAllister studies convex and discrete geometry, with a focus on the theory of lattice-point enumeration in polyhedra and its applications to algebraic geometry, representation theory, and geometric invariant theory.

Eric Moorhouse (PhD, University of Toronto, 1987)
Professor
Research Interests: Finite geometry
RH216, 6-4394, `moorhous`

Eric Moorhouse's mathematical interests include projective geometry, codes and designs, non-associative structures, algebraic combinatorics, and information theory. He tries to use a variety of tools, both experimental (practical programming with computers) and theoretical (methods from group theory, algebraic geometry, number theory and mathematical logic).

Zhuang Niu (PhD, University of Toronto, 2005)
Assistant Professor
Research Interests: C^* Algebras
RH311, 6-6887, `zniu`

Zhuang Niu's research interests are in operator algebras, K-theory, and dynamical systems, which are linked through the study of noncommutative topological spaces.

Felipe Pereira (PhD, State University of New York–Stony Brook, 1992)
SER Professor
Research Interests: Numerical Analysis, Mathematical Modeling
RH316, 6-5091, `felipepereira62@gmail.com`

Felipe Pereira's expertise includes modeling and simulation of multiphase flows in heterogeneous oil reservoirs and aquifers, uncertainty quantification, numerical methods for PDEs and high performance computing.

Peter Polyakov (PhD, Moscow State University, 1971)
Professor
Research Interests: Several complex variables
RH226, 6-3192, `polyakov`

Peter Polyakov's research interests include analysis of solvability and uncertainty quantification for nonlinear PDEs in multiscale modeling, and the theory of functions of several complex variables.

Bryan Shader (PhD, University of Wisconsin, 1990)
Professor
Research Interests: Combinatorics, linear algebra
RH321, 6-6826, `bshader`

Bryan Shader's mathematical interests include combinatorial matrix theory, algebraic graph theory, and qualitative matrix analysis.

Chanyoung Shader (PhD, University of Wisconsin, 1991)
Associate Professor
Research Interests: Algebra
RH323, 6-4157, `chan`

Chanyoung Shader's research focuses on representation theory of Lie algebras, Lie superalgebras, and quantized alegbras. Her research interests include construction of representations and formulation of characters using combinatorial methods.

Dan Stanescu (PhD, Concordia University, 1999)

Associate Professor
Research Interests: Numerical analysis, computational fluid dynamics
RH218, 6-4380, `stanescu`

Dan Stanescu's research interests are centered around the the numerical simulation of fluid flow. He is also interested in the numerical modeling of stochastic differential equations, uncertainty quantification and mathematical biology.

Jason Williford (PhD, University of Delaware, 2004)
Associate Professor
Research Interests: Finite geometry, graph theory, association schemes
RH314, 6-2209, `jwillif1`

Jason Williford's mathematical interests center around the interplay between algebra, finite geometry, and combinatorics. In particular, he is interested in association schemes and coherent configurations. He also studies extremal problems in graph theory that can be approached using constructions from finite fields and geometries.

Man-Chung Yeung (PhD, University of California–Los Angeles, 1997)
Associate Professor
Research Interests: Numerical Analysis
RH 213, 6-4012, `myeung`

Man-Chung Yeung's research fields of interest are in iterative methods, preconditioning techniques, and parallel computations.

7.2. **Lecturers.**

David Anton (MS, Wyoming, 2007)
Associate Lecturer, Director of the Math Lab
RH029, 6-6577, `danton`

Nathan Clements (DA, Idaho State, 2012)
Assistant Lecturer, Calculus Coordinator
RH304, 6-5088, `nclemen1`

Jon Prewett (MS, Idaho, 1998)
Senior Lecturer, Summer School Director
RH 313, 6-4014, `jprewett`

Jeff Selden (PhD, Arizona, 2004)
Associate Lecturer
RH 211, 6-2280, `jselden`

John Spitler (MS, Wyoming, 1998)
Senior Lecturer
RH 318, 6-4205, `spitler`

Cindy Vadnais (BS, Wyoming, 1987)

Assistant Lecturer
RH207, 6-6432, cynv

William Weber (MS, Wyoming, 1994)
Senior Lecturer
RH225, 6-6547, wsweber

7.3. **Staff.**

Beth Buskirk
Office Associate, Senior & Graduate Coordinator
RH203 , 6-6546, bbuskirk

Vicki Staddie
Accounting Associate, Senior
RH222, 6-4222, vstaddie

Leslie Roan
Office Associate
RH202, 6-4221, lroan

7.4. **Recent Graduates.** The list below shows the thesis titles for some of our recent graduates. Initial placement is also indicated (when known).

2014: Cara Wiblemo, PhD (Hobart)
"Automorphism Decompositions of Graphs"

2014: Bradley McCaskill, MS (Ginting)
"A Multiscale Domain Decomposition Method in Conservation Problems"
First Position: PhD Program, Mathematics, UW

2014: Alex Karanevich, MS (Williford)
"Load Balancing for Markov Chains with a Specified Graph"

2014: George Shakan, MS (Moorhouse)
"A Bound for the Sum of Dilates"

2014: Russell Johnson, MS (Polyakov)
"Stochastic Upscaling of Solutions of Differential Equations"
First Position: PhD Program, Mathematics, UW

2013: Michael Sollami, PhD (Douglas)
"Ternary Squarefree Words"
Mustbin, Inc.

2013: Stephen Garth, MS (Hall)
"Pairing-friendly Curves"

2013: Lawrence Bush, PhD (Ginting)
"On the Postprocessing Techniques of the Continuous Galerkin Finite Element"

2013: Joyce Rigelo, PhD (Pereira)
"A New Multiscale Mixed Method and Uncertainty Quantification Technique for Porous Media Flows"
First Position: Post-doc, Petroleum & Geosystems Engineering, U. Texas at Austin

2013: Saroj Aryal, PhD (Jafari)
"Sparse Moment Problems"
First Position: Assistant Professor (tenure track), Montana State U., Billings

2013: Jared Skinner, MS (Moorhouse)
"On the Free Closure of a Partial Linear Space"
First Position: Dart, Inc.

2013: Kevin Lenth, PhD (Polyakov)
"Application of a Perturbation Method to Nonlinear Stochastic PDEs"
First Position: Faculty, Casper College

2012: Derrick Cerwinsky, PhD (Douglas)
"The Theory and Practice of Algebraic Multigrid Methods"
First Position: Post-doc, U. Wyoming

2012: Xin Li, MS (Douglas)
"Hybrid Numerical Methods for GPS Receivers"

2012: Eric Quade, PhD (Lyng)
"A New Construction of Viscous Weak Detonation Profiles"
First Position: Faculty, Laramie County Community College

2011: Chandana Wijeratne, PhD (Bessaih)
"On Stochastic Shell Models of Turbulence"

2011: Colin Garnett, PhD (B. Shader)
"The Nilpotent-Centralizer Method and its Applications"
First Position: Post-doc, U. Victoria

2011: Saikat Mukherjee, PhD (Jafari)
"Composition Operators on Paley–Wiener Type Spaces"
First Position: Assistant Professor (Visiting), U. of Minnesota, Morris.

2011: B. P. W. Fernando, PhD (Sritharan)
"Stochastic Navier–Stokes Equation with Itô–Lévy Noise"
First Position: Post-doc, Naval Postgraduate School

2011: Celestin Zemtsop, PhD (Heinz)
"Unified RANS/LES Simulations of Turbulent Swirling Jet Flows"
First Position: Post-doc, U. Wyoming

Part C. **Courses**

8. Graduate Courses

Note: This catalog listing includes some proposed changes that are under review . The official catalog descriptions of mathematics courses may be found at

`www.uwyo.edu/registrar/university_catalog/` .

5100. Seminar in Elementary School Mathematics. 1 - 4 (Max. 8). A course to give graduate students in mathematics education, or in-service teachers, an in-depth view of new contents, materials, and strategies for teaching mathematics in elementary schools. The course is primarily designed to meet the needs of students

working towards M.S.N.S., M.S.T., M.A.T. degrees. Prerequisite: 6 hours of MATH 4100.

5110. Modeling Flow Transport in Soil and Groundwater Systems. 4. Mathematical models are formulated and applied to simulate water flow and chemical transcript in soil and groundwater systems. Soil spatial variability and heterogeneity are considered in the modeling processes. Using and comparing models, students obtain the capability to transfer a physical problem to a mathematical model, to use numerical methods, such as the finite element methods, to solve the mathematical problem, and to correctly interpret the numerical outputs. Students develop and program numerical solutions for select problems and utilize existing codes for modeling a variety of comprehensive problems. Cross listed with SOIL 5110.

5140. Numbers, Operations, and Patterns for the Middle-level Learner. 3. Provides working middle-level mathematics teachers opportunities to understand and discuss numbers, their representations, and operations on them from an abstract perspective that includes elegant proof. Also emphasized is the role of language and purpose in composing definitions. Cross listed with NASC 5140. Prerequisites: admission to a university graduate program, in either degree or non-degree seeking status, and acceptance into the Middle-level Mathematics Program.

5150. Seminar in Secondary School Mathematics. 1-4 (Max. 18). Seminar in Secondary School Mathematics. Prerequisite: 6 hours of MATH 4150.

5160. Social and Historical Issues in Mathematics and the Middle-Level Learner. 3. Empowers teachers of middle-level mathematics to design more engaging experiences. Emphasizes the historical context for the development of mathematics, especially its symbols, tools, personalities, and classic problems. Cross listed with NASC 5160. Prerequisites: admission to a UW graduate program, in either degree or non-degree seeking status, and acceptance into the Middle-level Mathematics Program.

5170. Connecting Geometry with Problem-Solving for the Middle-Level Learner. 3. Showcases two aspects of 2D and 3D geometry: measurement and transformation. Emphasis reflects current state and national standards for middle-level mathematics classroom and teacher preparation, especially appropriate uses of technology, geometric tools, mathematical language, and problem-solving strategies. Cross listed with NASC 5170. Prerequisites: admission to a university graduate program, in either degree or non-degree seeking status, and acceptance into the Middle-level Mathematics Program.

5190. Mathematics of Change and the Middle-Level Learner. 3. Students gain a solid understanding of data and functions in the service of calculus. Course is hands-on, project-driven and focuses on the essential concepts of functions and calculus and their role in middle-level mathematics. Emphasis is on writing and technology (calculators and probeware). Cross listed with NASC 5190. Prerequisites: admission to a UW graduate program, in either degree or non-degree seeking status, and acceptance into the Middle-level Mathematics Program.

5200. Real Variables I. 3. Develops the theory of measures, measurable functions, integration theory, density and convergence theorems, product measures, decomposition and differentiation of measures, and elements of function analysis on L^p spaces. Lebesgue theory is an important application of this development. Prerequisite: MATH 4200.

5205. Real Variables II. 3. A continuation of MATH 5200. Prerequisite: MATH 5200.

5230. Complex Variables I. 3. Develops the function theory of holomorphic (analytic) and harmonic functions. Topics covered include the Cauchy-Riemann equations, Cauchy-Goursat theorem, Cauchy integral theorem, Morera's theorem, maximum modulus theorem, Liouville's theorem, power series representation, harmonic functions, theory of singularities of functions of one complex variable, contour integration, analytic continuation, Riemann mapping theorem and topology of spaces of holomorphic functions. Prerequisite: MATH 4200.

5235. Complex Variables II. 3. A continuation of MATH 5230. Prerequisites: MATH 5230.

5260. Probability and Random Processes. 3. Elements of measure theory, mathematical properties of random variables, independence, conditional probability, probability distributions in $\mathbb{R}^n$, limit theorems and modes of convergence, Markov chains, martingales and Brownian processes. Prerequisites: MATH 4200 or 4255.

5265. Introduction to the Theory of Statistics. 3. Presents derivations of theoretical and sampling distributions. Introduces theory of estimation and hypothesis testing. Dual listed with MATH 4265, cross listed with STAT 5265. Prerequisites: STAT 4250/5250, MATH 4250.

5270. Functional Analysis I. 3. Topics include the geometry of Hilbert spaces, linear functions and operators on Hilbert spaces, spectral theory of compact normal operators, Banach space theory, the open mapping theorem, Hahn-Banach theorem, Banach-Steinhaus theorem, duality and linear operators on Banach spaces, and different topologies on Banach spaces and their duals. Prerequisite: MATH 5200.

5275. Functional Analysis II. 3. Topics may include discussion of topological vector spaces, locally convex spaces, F-spaces, spectral theory of non-compact operators on Hilbert spaces, semigroups or evolution operators, distribution theory, and applications to differential equations and Sobolev spaces. Prerequisite: MATH 5270.

5290. Topics in Analysis. 1-6 (Max. 18). Topics in analysis. Prerequisite: consent of instructor.

5310. Computational Methods in Applied Sciences I. 3. First semester of a three-semester computational methods series. Review of iterative solutions of linear and nonlinear systems of equations, polynomial interpolation/approximation, numerical integration and differentiation, and basic ideas of Monte Carlo methods. Comparison of numerical techniques for programming time and space requirements, as well as convergence and stability. Identical to COSC 5310. Prerequisite: MATH 3310, COSC 1010.

5320. Mathematical Modeling Processes. 3. Introduction to techniques in the process of constructing mathematical models. Application of the techniques to areas such as petroleum reservoir simulation, chemical process industry operations, and plant start-up. Identical to CHE 5870. Prerequisite: MATH 5310 and graduate standing.

5340. Computational Methods II. 3. Second semester of a three-semester computational methods series with emphasis on numerical solution of differential equations. Topics include explicit and implicit methods, methods for stiff ODE problems, finite difference, finite volume, and finite element methods for time-independence PDEs semi/fully discrete methods for time-dependent PDEs. Cross listed with COSC 5340. Prerequisite: MATH 5310.

5345. Computational Methods III. 3. Third semester of a three-semester computational methods series with emphasis on numerical solution of problems displaying sharp fronts and interfaces (nonlinear conservation laws, Hamilton-Jacobi equations). Cross listed with COSC 5345. Prerequisite: MATH 5340.

5390. Topics in Numerical Analysis. 1 - 6. (Max 18). Topics in numerical analysis. Prerequisite: consent of instructor.

5400. Methods of Applied Mathematics I. 3. First semester of a one-year survey of topics and methods of applied mathematics, with emphasis on applications from physics and engineering. The full sequence includes introductions to mathematical aspects of mechanics (e.g., conservation laws), asymptotic expansions, systems of ODE and stability, integral equations and calculus of variations, PDE with boundary value problems and generalized solutions (including wave, heat, and potential equations), numerical methods and stability. Prerequisite: MATH 2250, 4200, and 2310 or 4430.

5405. Methods of Applied Mathematics II. 3. A continuation of MATH 5400. Prerequisite: MATH 5400.

5410. Applied Partial Differential Equations. 3. A one-semester course in partial differential equations (PDE) from the perspective of physical applied mathematics. Special attention is paid to mathematical issues related to the mathematical modeling of real-world phenomena including nonlinearity and well-posedness. Topics include first-order quasilinear PDE, characteristics, Cauchy–Kovalewski theorems, and linear and nonlinear examples of hyperbolic, elliptic, and parabolic equations. Prerequisites: MATH 2210, MATH 2310, and MATH 4200.

5420. Advanced Logic. 3. Studies advanced topics in mathematical logic. Takes up such topics as: uninterpreted calculi and the distinctive contributions of syntax and semantics; methatheory, including completeness and consistency proofs; modal logic and semantics; logic as a philosophical tool. Dual listed with MATH 4420; cross listed with COSC/PHIL 5420. Prerequisite: PHIL 3420 or equivalent; graduate standing.

5430. Differential Equations & Dynamical Systems. 3. Differential equations constitute the mathematical language for problems of continuous change. ODEs deal with evolutionary processes involving one independent variable. This course

revisits solution techniques but emphasizes the theoretical framework. Topics include: existence and uniqueness, linear and nonlinear differential systems, asymptotics and perturbations, and stability. Prerequisite: MATH 4200, 4430.

5440. Mathematical Theory of Partial Differential Equations . 3. Introduction to an array of topics from the mathematical theory of linear and nonlinear PDE. Topics may include Sobolev spaces, weak solutions to elliptic PDE, elliptic regularity theory, spectral theory of elliptic operators, linear parabolic and hyperbolic equations, distribution theory, elements of calculus of variations and applications to nonlinear elliptic PDE, systems of conservation laws, semi-group theory, reaction-diffusion equations, Schauder theory, Navier–Stokes equations, bifurcation theory. Prerequisites: MATH 5200 or MATH 5410.

5490. Topics in Applied Mathematics. 1-6 (Max. 18). Prerequisite: consent of instructor.

5500. Advanced Linear Algebra. 3. An introduction to the theory of abstract vector spaces and linear transformations from an axiomatic point of view, with applications to matrix theory. Topics include vector spaces, dimension, linear transformations, dual spaces and functionals, inner product spaces, and structure theorems. Prerequisite: MATH 3500 and 4500.

5510. Combinatorial Theory. 3. An introduction to combinatorics covering both classical and contemporary topics. Includes some of the following: generating functions, recursion formulas, partially ordered sets, inclusion- exclusion, partitions, graph theory, Ramsey theory, combinational optimization, Latin squares, finite geometries, and design theory. Prerequisite: consent of instructor.

5530. The Theory of Groups. 3. An in-depth study of various aspects of group theory, building on MATH 5550. Topics include some of the following: classical theory of finite groups (both Abelian and non-Abelian), infinite Abelian groups, free groups, permutation groups, group representations, endomorphism, extensions, and cohomology. Prerequisite: MATH 5550.

5550. Abstract Algebra I. 3. Studies the structure of groups, rings, and fields. For each, concepts of substructures, quotient structures, extensions, homomorphism, and isomorphism are discussed. Prerequisite: MATH 3500 or 5500.

5555. Abstract Algebra II. 3. A continuation of MATH 5550, examining in depth selected topics from the theory of rings, fields, and algebras, including Galois theory. Prerequisite: MATH 5550.

5570. Matrix Theory and Combinatorics. 3. An overview of matrix theory and its applications to combinatorics. Topics include Smith normal form, the Perron-Frobenius theory of non-negative matrices, location and perturbation of eigenvalues, and interlacing of eigenvalues. Applications include structure theorums for (0,1)-matrices, network flows, spectra of graphs, and the permanent. Prerequisite: MATH 5500.

5590. Topics in Algebra. 1-6 (Max. 18). Topics in algebra. Prerequisites: consent of instructor.

5600. Point-Set Topology. 3. Topics considered are metric spaces, open spheres, open sets, closed sets, continuous functions, limit points, topological spaces, homeomorphisms, compactness, connectedness, and separability. The familiar notion of distance on the real number line is generalized to the notion of a metric for an arbitrary set, which is in turn generalized to the concept of a set topology for a set. Certain applications to analysis and geometry are indicated. Prerequisite: MATH 3205.

5605. Algebraic Topology. 3. Topics in algebraic topology, including simplicial homology groups and their topological invariance, the Eilenberg-Steenrod axioms, singular homology theory, and cohomology. Prerequisite: MATH 3500.

5640. Differential Geometry. 3. Curve theory, theory of surfaces, and geometrics on a surface. Prerequisite: MATH 4200 or 4400.

5690. Topics in Topology. 1-6 (Max. 9). Prerequisite: consent of instructor.

5700. Topics in Combinatorics. 1 - 6 (Max. 18). Selected topics in combinatorial analysis. Prerequisite: consent of instructor.

5800. Seminar in Mathematics. 1-3 (Max. 8). Prerequisite: consent of Instructor.

5900. Practicum in College Teaching. 1-3 (Max. 3). Work in classroom with a major professor. Expected to give some lectures and gain classroom experience. Prerequisite: graduate status.

5920. Continuing Registration: On Campus. 1-2 (Max. 16). Prerequisite: advanced degree candidacy.

5940. Continuing Registration: Off Campus. 1-2 (Max. 16). Prerequisite: advanced degree candidacy.

5959. Enrichment Studies. 1-3 (Max. 99). Designed to provide an enrichment experience in a variety of topics. Note: credit in this course may not be included in a graduate Program of Study for degree purposes.

5960. Thesis Research. 1-12 (Max. 24). Graduate level course designed for students who are involved in research for their thesis project. Also used for students whose coursework is complete and are writing their thesis. Prerequisite: enrollment in a graduate degree program.

5980. Dissertation Research. 1-12 (Max. 48). Graduate level course designed for students who are involved in research for their dissertation project. Also used for students whose coursework is complete and are writing their dissertation. Prerequisite: enrollment in a graduate level degree program.

5990. Internship. 1-12 (Max. 24). Prerequisite: graduate standing.

Part D. **Other Attractions**

9. Nearby: the great outdoors and more

The nearby Medicine Bow National Forest and Rocky Mountains provide quick access to hiking, biking, fishing, hunting, or camping. Within 20 minutes, you can take on a challenging mountain bike ride, Nordic ski trail, or scale the massive granite monoliths of the Vedauwoo formation. Dive into great Rocky Mountain powder on the slopes of the Snowy Range Ski Area, just 40 minutes from campus. Denver is less than two-and-a-half hours away and offers

big-city amenities: shopping, concerts, theatre, professional sporting events, and international flight connections.

Denver, CO	2–2$\frac{1}{2}$ hours.
Fort Collins, CO	1 hour.
Cheyenne, WY	45 minutes.
Snowy Range Ski Area	40 minutes.
Steamboat Ski Area	2$\frac{1}{4}$ hours
Cross-Country skiing	20 minutes.
Vedauwoo	15 minutes.

Table 1. Approximate driving times from Laramie.

10. Athletics & Cultural Events

10.1. **Campus Recreation and Athletics.** UW is a member of the Mountain West Conference, and the Cowboys & Cowgirls compete in 15 total NCAA Division I sports. In addition, Campus Recreation offers a complete program of club and intramural sports, fitness facilities, and an active Outdoor Program. Half Acre Gym, one of the principal fitness and recreation facilities on campus, is currently undergoing a $27M renovation project.

USEFUL LINKS

UW Athletics: `www.gowyo.com/`

Campus Recreation: `www.uwyo.edu/rec/`

10.2. **Cultural and artistic life.** There is an active cultural and artistic scene in Laramie. The music department and the department of theatre and dance put on a wide variety of on-campus performances through out the year. These include many student-driven offerings as well as performances from eminent artists-in-residence, and an annual summer theatre and dance festival. In addition, UW sponsors an annual program of professional music and dance performances on campus. The fine arts building is currently undergoing a $35M renovation project to create a state-of-the-art performance venue.

USEFUL LINKS

UW Cultural Programs: `www.uwyo.edu/culturalprogram`

UW Theatre & Dance: `www.uwyo.edu/thd/whats-playing/`