GRADUATE COURSES (AT NORTH CAROLINA STATE UNIVERSITY)

Course: **Doctoral Supervised Research, MA 893.**

In Progress **(Spring 2022)**.

Course Description: Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Course: **Doctoral Supervised Teaching, MA 885.**

Completed **(Fall 2021)**.

Course Description: Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Course: **Linear Algebra, MA 520, Dr. Kailash C. Misra.**

Completed **(Fall 2021)**. Ph.D. written qualifying examination.

Course Description: Vector spaces. Bases and dimension. Changes of basis. Linear transformations and their matrices. Linear functionals. Simultaneous triangularization and diagonalization. Rational and Jordan canonical forms. Bilinear forms.

Course: **Abstract Algebra I, MA 521, Dr. Corey Jones.**

Completed **(Fall 2021)**. Ph.D. written qualifying examination.

Course Description: Groups, quotient groups, group actions, Sylow's Theorems. Rings, ideals and quotient rings, factorization, principal ideal domains. Fields, field extensions, Galois theory.

Course: **Probability and Stochastic Processes I, MA 546, Dr. Min Kang.**

Completed **(Fall 2021)**. Audited. Ph.D. written qualifying examination.

Course Description: Modern introduction to Probability Theory and Stochastic Processes. The choice of material is motivated by applications to problems such as queueing networks, filtering and financial mathematics. Topics include: review of discrete probability and continuous random variables, random walks, markov chains, martingales, stopping times, erodicity, conditional expectations, continuous-time Markov chains, laws of large numbers, central limit theorem and large deviations.

Course: **Biomathematics I, BMA 771, Dr. Kevin Flores.**

Completed **(Fall 2021)**. Audited.

Course Description: Canonical forms, functions of matrices, variational methods, perturbation theory, numerical methods, nonnegative matrices, applications to differential equations, Markov chains.

Course: **Lie Algebras, MA 720, Dr. Kailash C. Misra.**

In Progress **(Spring 2022)**. Ph.D. written qualifying examination.

Course Description: Definition of Lie algebras and examples. Nilpotent, solvable and semisimple Lie algebras. Engel's theorem, Lie's Theorem, Killing form and Cartan's criterion. Weyl's theorem on complete reducibility. Representations of s1(2,C). Root space decomposition of semisimple Lie algebras. Root system and Weyl group.

Course: **Abstract Algebra II, MA 721, Dr. Corey Jones.**

In Progress **(Spring 2022)**. Ph.D. written qualifying examination.

Course Description: Module theory including the structure theory of modules over a PID and primary decomposition; Tensor, exterior, and symmetric algebras; introductory homological algebra including: complexes, derived functors, Ext and Tor; and the representation theory of groups. Further topics will be covered as time permits.

Course: **Theory of Matrices and Applications, MA 723, Dr. Dávid Papp.**

In Progress **(Spring 2022)**. Ph.D. written qualifying examination.

Course Description: Canonical forms, functions of matrices, variational methods, perturbation theory, numerical methods, nonnegative matrices, applications to differential equations, Markov chains.

Course: **Introduction to Complex Variables, MA 513, Dr. Andrew Manion.**

In Progress **(Spring 2022)**.

Course Description: Operations with complex numbers, derivatives, analytic functions, integrals, definitions and properties of elementary functions, multivalued functions, power series, residue theory and applications, conformal mapping.

ADVANCED UNDERGRADUATE COURSES

(AT BEREA COLLEGE – BEREA, KENTUCKY, USA

AND THE BUDAPEST SEMESTERS IN MATHEMATICS, HUNGARY, EUROPE)

MATHEMATICS – UNDERGRADUATE RESEARCH

Course: **Undergraduate Research, UGR010, Dr. Kristen Barnard.**
Completed **(Summer 2020)**. Grade earned: **S (Satisfactory)**.
Research Paper:
https://thmolena.github.io/thmolena/T.H.MOLENA-INDEPENDENT-RESEARCH.pdf
Course Description: Combinatorial game theory is a branch of discrete mathematics that seeks to find patterns and strategies for winning particular types of games. These games, called combinatorial games, have several defining features.
Combinatorial game theory is an interesting and approachable area of research for mathematicians at all levels. An unfortunate truth about mathematics research is that many open problems and research areas require a great deal of background knowledge that is both unrealistic to assume that an undergraduate researcher would have been exposed to and not feasible to teach them during an 8-week period while still having time to work toward new results. Alternatively, problems in combinatorial game theory are usually very clearly stated, and researchers are able to get involved from the very beginning, regardless of their background knowledge in mathematics. Further, problems solved in combinatorial game theory are of interest to the computer science community as game strategies are used in furthering advances in artificial intelligence and machine learning.

MATHEMATICS – ANALYSIS

Course: **Real Functions and Measures, Dr. Péter Maga (Research Fellow)**.
Taste of BSM-Spring 2021 Online Learning Opportunity at the **Budapest Semesters in Mathematics, Alfréd Rényi Institute of Mathematics, Hungarian Academy of Sciences**.
Completed (**Spring 2021**). Grade earned: **Audited**. Textbook: **Professor's Lecture Notes**.
Course Description: This course provides an introduction into the Lebesgue theory of real functions and measures.

Topics: Topological and measurable spaces. The abstract theory of measurable sets and functions, integration. Borel measures, linear functionals, the Riesz theorem.
Bounded variation and absolute continuity. The Lebesgue-Radon--Nikodym theorem.
The maximal theorem. Differentiation of measures and functions. Density. Haar measure. (if time permits)

Course: **Real Analysis, MAT 434, Dr. James Blackburn – Lynch**.
Completed (**Fall 2019**). Grade earned: **A**.
Textbook: **Bartle and Sherbert, Introduction to Real Analysis**.
(ISBN: 978-0471433316 / 9780471433316)
Course Description: Basic algebraic and topological properties of the real number system will be established and then applied to the study of such concepts as limit, continuity, differentiation, integration, and infinite series.

Course: **Numerical Analysis, MAT 433 (CSC), Dr. Larry Gratton**.
Completed (**Spring 2020**). Grade earned: **A**. Textbook: **Professor's Lecture Notes**.
Course Description: This course is designed for students who are concerned with the development of approximation methods and their use in locating roots of equations, interpolation, numerical differentiation, numerical integrations, and solution of systems of linear equations.

Course: **Differential Equations, MAT 337, Dr. Larry Gratton**.
Completed (**Fall 2019**). Grade earned: **A**.
Textbook: **Trench, Elementary Differential Equations**
(**Trinity University Digital Commons @ Trinity**).
Course Description: This course provides an introduction to both pure and applied aspects of differential equations. Topics to be studied include first-order equations, second-order linear equations, power-series solutions, Laplace Transforms, systems of first-order equations, and nonlinear equations.

MATHEMATICS – ALGEBRA

Course: **Directed Study in Advanced Abstract Algebra, MAT 498,**
Dr. James Blackburn – Lynch (Continued from MAT 432).
Completed (**Fall 2020**). Grade earned: **A**.
Textbook: **Herstein, Abstract Algebra**. (ISBN: 978-0471368793 / 0471368792).
Course Description: A course designed to introduce students to the methods and topics essential to the study of algebraic structure and its implications. An introduction to group theory will serve to launch an investigation of more highly structured algebras such as rings, integral domains, and fields.

Course: **Abstract Algebra, MAT 432, Dr. James Blackburn – Lynch**.
Completed (**Spring 2020**). Grade earned: **A**.
Textbook: **Herstein, Abstract Algebra**. (ISBN: 978-0471368793 / 0471368792).
Course Description: A course designed to introduce students to the methods and topics essential to the study of algebraic structure and its implications. An introduction to group theory will serve to launch an investigation of more highly structured algebras such as rings, integral domains, and fields.

Course: **Linear Algebra, MAT 214, Dr. James Blackburn – Lynch**.
Completed (**Fall 2019**). Grade earned: **A+**.
Textbook: **Lay, Linear Algebra and Its Applications**.
(ISBN: 978- 0321385178 / 0321385179).
Course Description: This course illustrates the nature of mathematics as a blend of techniques, theory, abstraction, and applications. The problem of solving linear equations leads to the algebra of matrices, determinants, vector spaces, bases and dimensions, linear transformations, and eigenvalues.

MATHEMATICS – GEOMETRY

Course: **Foundations of Geometry, MAT 321, Dr. James Blackburn – Lynch**.
In Progress (**Spring 2021**).
Textbook: **Moise, Elementary Geometry from An Advanced Standpoint**.
(ISBN: 978-0201508673 / 0201508672).
Course Description: This course will include an overall view of the structure of geometry evolving from the basic axioms of Euclidean geometry. The interrelationships between various geometries such as affine, neutral, hyperbolic, projective, elliptic, and others will be studied, as well as some of the easier, important results of each. Because this material is necessary for a good understanding of Euclidean geometry, it is important that those students considering a high-school teaching career in mathematics enroll in this course.

MATHEMATICS – STATISTICS

Course: **Statistics, MAT 438, Dr. Jean Cupidon.** (Continued from MAT 311)**.**
Completed (**Spring 2021**). Grade earned: **A**.
Textbook: **Larson, Introduction to Probability Theory and Statistical Inference**.
(ISBN: 978-0471059097 / 0471059099)
Course Description: A continuation of MAT 311. The student should gain an appreciation of the nature, scope, and theoretical basis of methods of statistical inference. Topics will include estimation, hypotheses testing, and linear regression. Applications will be discussed.

Course: **Probability, MAT 311, Dr. Jean Cupidon**.
I had never taken this course, but I was an in-class Teaching Assistant for this course.
(**Fall 2020**).
Textbook: **Larson, Introduction to Probability Theory and Statistical Inference**.
(ISBN: 978- 0471059097 / 0471059099)
Course Description: The goal of this course is to introduce students to the fundamental concepts of Probability theory and its applications. Topics include random experiments, outcomes, and events; conditional probability and independence; random variables; discrete and continuous distributions; moment generating functions; jointly distributed random variables; and the Central Limit Theorem.

MATHEMATICS – COMBINATORICS

Course: Advanced Abstract Algebra, Dr. Peter Hermann (Associate Professor).
Taste of BSM-Spring 2021 Online Learning Opportunity at **Budapest Semesters in Mathematics, Eötvös University**, **Alfréd Rényi Institute of Mathematics**.
Completed (**Spring 2021**). Grade earned: **Audited**. Textbook: **Professor's Lecture Notes**.
Course description: The course attempts to give an idea of some basic methods in finite and infinite group theory. We shall cover topics like permutation actions, the Sylow-theorems, finite permutation groups, some properties of p-groups, the Schur - Zassenhaus theorem, the transfer and its applications, solvable groups, nilpotent groups, free groups. A brief introduction to character theory of finite groups.

Course: **Combinatorics, MAT 415, Dr. Kristen Barnard**.
Completed (**Spring 2020**). Grade earned: **A**.
Textbook: **Bogart, Combinatorics Through Guided Discovery**.
(ISBN: 978-1981746590 / 1981746595).
Course Description: Discrete Mathematics is a branch of mathematics concerning countable discrete structures. Discrete problems arise in many different areas of pure mathematics ranging from abstract algebra to probability theory, but there are many applied uses of combinatorial knowledge in fields such as computer science or physics. The goals of the course will be to develop skills in identifying typical problems and formulating, solving, and interpreting appropriate models. Topics of the course will include the Pigeonhole Principle, Ramsey Numbers, Algorithms (Greedy, Breadth-First, Depth-First, Brute Force), recurrence relations, Graph Theory (graphs, digraphs, trees, bipartite graphs, matchings, coloring, graph isomorphisms, planarity), multisets, compositions, permutations, integer partitions, ordinary and exponential generating functions, the Principle of Inclusion and Exclusion, and other topics as time or student interest permits.

MATHEMATICS – FOUNDATIONAL COURSES

Course: **Calculus III, MAT 330, Dr. James Blackburn – Lynch**.

Completed (**Spring 2020**). Grade earned: **A**.

Textbook: **Hughes (and 14 other authors), Calculus: Single and Multivariable**

(ISBN: 978-0470888612 / 047088861X)

Course Description: Main topics include three dimensional vectors, space, curves, solid analytic geometry, differential calculus of several variables, and multiple integration. Microcomputer graphics and computational packages will be introduced and used in the analysis of selected problems.

Course: **Fundamental Concepts of Math, MAT 315, Dr. James Blackburn – Lynch**.

Completed (**Spring 2019**). Grade earned: **A**.

Textbook: **Fletcher and Patty, Foundations of Higher Mathematics**

(ISBN: 978-0534951665 / 053495166X)

Course Description: Designed to acquaint students with some of the concepts and methods fundamental to all areas of mathematics. Topics will include set theory, relations, functions, logic, methods of proof, cardinality, and selected properties of the real number system.

COMPUTER SCIENCE

Course: **Computational Intelligence, CSC 410, Dr. Mario Nakazawa**.

Completed (**Fall 2020**). Grade earned: **A**.

Textbook: **Eberhart and Shi, Computational Intelligence: Concepts to Implementations**

(ISBN: 978-1558607590 / 1558607595)

Course Description: An introduction to artificial intelligence through an area called "machine learning," this course focuses on the principles and implementation practices of programs that search for solutions to problems using heuristic algorithms. Students will learn how to create programs and test simulators that demonstrate how computer systems can (a) 'intelligently' find solutions and (b) adapt and learn to respond correctly to new problem sets.

Course: **Theory of Computation, CSC 303, Dr. Mario Nakazawa**.

Completed (**Spring 2021**). Grade earned: **A**.

Textbook: **Brookshear**, **Theory of Computation: Formal Languages, Automata, And Complexity** (ISBN: 978-0805301434 / 0805301437).

Course Description: An introduction to the fundamental ideas and the basic paradigms of computer science, the very foundation on which to base one's thinking about computers now and in the future. This course will address some of the following topics in the theory of computation, the theory of automata and formal languages, computability by a Turing machine, and computational complexity. Computational tasks that cannot be solved on any computer or tasks where there is no practical, reasonably fast algorithm to solve them will be considered. The perspective here is from that of computing, but the treatment is mathematical in nature.

Course: **Data Structures, CSC 236, Dr. Jan Pearce.**

Completed (**Spring 2020**). Textbook: **Professor's Lecture Notes**

Course Description: This course continues the study of software design and implementation from an object-oriented perspective. The design and implementation of software is fundamentally about tradeoffs between how fast our code runs and the amount of memory it consumes while running. We will explore the common structure used to represent data (queues, lists, trees, and hash tables, to name a few), the design tradeoffs we must make when choosing between them, and the experimental analysis of our algorithms and structures as expressed in code.