

DEPARTMENT OF MATHEMATICAL SCIENCES

College of Arts and Sciences

Department of Mathematical Sciences
233 Mathematics and Computer Science Building
Kent Campus
330-672-2430
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Undergraduate Programs

- Applied Mathematics - B.S.
- Mathematics - B.A.
- Mathematics - B.S.

Minors

- Applied Mathematics
- Applied Statistics
- Mathematics

Graduate Programs

- Applied Mathematics - M.A.
- Applied Mathematics - M.S.
- Applied Mathematics - Ph.D.
- Mathematics for Secondary Teachers - M.A.
- Pure Mathematics - M.A.
- Pure Mathematics - M.S.
- Pure Mathematics - Ph.D.

Department of Mathematical Sciences Faculty

- Adams, Lynn (2007), Associate Lecturer, M.S., University of Akron, 2007
- Ahuja, Om P. (2000), Professor, Ph.D., University of Khartoum, 1981
- Alexopoulos, John K. (1994), Associate Professor, Ph.D., Kent State University, 1992
- Allouba, Hassan A. (2002), Associate Professor, Ph.D., Cornell University, 1996
- Altobelli, Joseph A. (1997), Associate Professor, Ph.D., The Ohio State University, 1996
- Andaloro, Paul J. (1994), Assistant Professor, Ph.D., The Ohio State University, 1989
- Andriyevskyy, Volodymyr (2000), Professor, Ph.D., Institute of Mathematics of Ukrainian Academy of Sciences, 1986
- Barb, Cynthia M. (1990), Associate Professor, Ph.D., Kent State University, 1997
- Chebotar, Mikhail (2006), Professor, Ph.D., Moscow State University, 1999
- Das, Lovejoy S. (1989), Professor, Ph.D., University of Lucknow, 1979
- Davidson, Morley A. (1996), Associate Professor, Ph.D., University of Michigan, 1995
- de la Cruz Cabrera, Omar (2016), Assistant Professor
- Del Pizzo, Lawrence F. (1969), Assistant Professor, M.A., Kent State University, 1969
- Dhaher, Yaser Y. (1989), Associate Professor, Ph.D., Kent State University, 2007
- Dialesandro, Jack J. (1983), Associate Lecturer, M.Ed., Kent State University, 1989
- Dinh, Hai Q. (2004), Professor, Ph.D., Ohio University, 2003
- Feng, Bao Qi (1996), Associate Professor, Ph.D., Kent State University, 2001
- Gagola, Stephen M. (1982), Professor, Ph.D., University of Wisconsin-Madison, 1974
- Gartland, Eugene C. (1987), Professor, Ph.D., Purdue University, 1980
- Gordon, Peter (2017), Associate Professor, Ph.D., Moscow University, 1999
- He, Min (1995), Professor
- Heinbach, Charles C. (1978), Senior Lecturer, B.A., Kent State University, 1977
- Hovhannisyian, Gro (2003), Associate Professor, Ph.D., Yerevan State University, 1990
- Hrubik-Vulanovic, Tatjana (2002), Assistant Professor, Ph.D., Kent State University, 2013
- Jahangiri, Jay M. (1994), Professor, Ph.D., University of York, 1986
- Jaye, Benjamin J. (2011), Assistant Professor
- Kasturiarachi, Aloysius Bathi (1995), Associate Professor
- Kellermann, Mary K. (1987), Senior Lecturer, M.A.T., Kent State University, 1993
- Khan, Mohammad K. (1981), Professor, Ph.D., Case Western Reserve University, 1980
- Kover, Janice S. (1996), Associate Professor, Ph.D., Kent State University, 2001
- Kracht, Darci L. (1984), Professor, Ph.D., Kent State University, 2011
- Kratky, Joseph J. (2005), Lecturer, M.S., Kent State University, 2011
- Laux, Tracy A. (1990), Senior Lecturer, B.S., Kent State University, 1990
- Lewis, Mark L. (1996), Professor, Ph.D., University of Wisconsin-Madison, 1995
- Li, Jing (2003), Associate Professor, Ph.D., New York University, 2002
- Li, Jun (2013), Assistant Professor, Ph.D., Iowa State University, 2013
- Lochmueller, Kerri K. (2005), Lecturer, M.S., Youngstown State University, 2008
- Lomonosov, Victor (1990), Professor, Ph.D., V.N. Karazin Kharkiv National University, 1974
- Meyer, Lorree L. (1994), Associate Lecturer, M.Ed., Kent State University, 2004
- Mikusa, Michael (1987), Associate Professor, Ph.D., Kent State University, 1993
- Minerovic, Joseph M. (1983), Associate Lecturer
- Mocioalca, Oana (2004), Associate Professor, Ph.D., University of Florida, 2002
- Muckridge, Nicole A. (2007), Lecturer, M.A., Kent State University, 2009
- Mulqueeny, Ellen S. (2005), Assistant Professor, M.S., Cleveland State University, 1993
- Najafi, Mahmoud (1995), Professor, Ph.D., Wichita State University, 1994

- Nazarov, Fedor L. (2011), Professor
- Osikiewicz, Beth-Allyn (1994), Associate Professor, Ph.D., Kent State University, 2000
- Osikiewicz, Jeffrey A. (1990), Associate Professor, Ph.D., Kent State University, 1997
- Perera, Vicumpriya S. (1998), Associate Professor, Ph.D., Purdue University, 1993
- Pham, Tuyet D. (1988), Associate Lecturer, M.S., University of Akron, 1988
- Polanski, Teresa S. (1987), Associate Lecturer, M.A.T., Kent State University, 1994
- Rajagopal, Parthasarathy (1987), Assistant Professor
- Rajaram, Rajeev (2008), Associate Professor, Ph.D., Iowa State University, 2005
- Reed, Beverly M. (1986), Associate Professor, Ph.D., Kent State University, 2007
- Reichel, Lothar (1991), Professor, University of Stockholm, Ph.D., 1982
- Rollick, Mary E. (1997), Associate Professor, Ph.D., Kent State University, 2007
- Ruchotzke, Randy L. (1994), Lecturer, M.A., Iowa State University, 1986
- Ruff, Oliver (2009), Associate Professor, Ph.D., University of Oregon, 2002
- Ryabogin, Dmitry (2007), Professor, Ph.D., University of Jerusalem, 2001
- Sharp, Mary Theresa L. (1997), Associate Professor, Ph.D., Kent State University, 2014
- Smithies, Laura A. (1997), Associate Professor, Ph.D., University of Utah, 1997
- Soprunova, Evgenia (2007), Associate Professor, Ph.D., University of Toronto, 2002
- Taha, Nader F. (1990), Associate Lecturer, M.S., Tennessee State University, 1989
- Tonge, Andrew M. (1985), Professor and Department Chair, Ph.D., University of Cambridge, 1976
- Vezvaei, Mahbobeh (1983), Professor, Ph.D., Case Western Reserve University, 1987
- Vorhauer, Ulrike M. (2001), Associate Professor, Ph.D., University of Ulm, 1996
- Vulcanovic, Relja (1992), Professor, Ph.D., University of Novi Sad, 1986
- Wakita, Hideki (1998), Associate Lecturer, M.A., Kent State University, 2002
- Wallach, Tracy A. (1984), Associate Lecturer, M.Ed., Kent State University, 1989
- White, Donald L. (1989), Professor, Ph.D., Yale University, 1987
- Wright, Brian M. (1998), Assistant Professor, Ph.D., Kent State University, 2007
- Yu, Gang (2006), Associate Professor, Ed.D., University of Georgia, 2000
- Zheng, Xiaoyu (2006), Associate Professor, Ph.D., University of North Carolina-Chapel Hill, 2006
- Zvavitch, Artem (2004), Professor, Ph.D., Weizmann Institute of Science, 2002

Mathematics (MATH)

MATH 00020 PRE-ALGEBRA 2 Credit Hours

Course covers properties of whole numbers, fractions, decimals, percents, signed numbers and order of operations. Mental math and elementary algebraic thinking skills are emphasized. Use of calculators is not allowed. Course does not count toward graduation.

Prerequisite: 0-9 ALEKS math score.

Schedule Type: Emporium

Contact Hours: 2 other

Grade Mode: Standard Letter

MATH 00021 BASIC ALGEBRA I 2 Credit Hours

Course includes operations on integers, fractions, decimals and percents, and properties of real numbers. Introduction to variables, first degree equations and problem-solving with formulas. Equations and inequalities in one variable, linear equations, rate of change and slope, graphing in the cartesian plane. Course does not count toward graduation.

Prerequisite: Minimum 10 ALEKS math score.

Pre/corequisite: Minimum C grade in MATH 00020.

Schedule Type: Emporium

Contact Hours: 2 other

Grade Mode: Standard Letter

MATH 00022 BASIC ALGEBRA II 2 Credit Hours

Introduction to functions, systems of linear equations, exponents, polynomial operations, scientific notation. Factoring polynomials, solving quadratics by factoring, radicals and rational exponents. Course does not count toward graduation.

Prerequisite: Minimum 25 ALEKS math score; or minimum C grade in MATH 00021.

Schedule Type: Emporium

Contact Hours: 2 other

Grade Mode: Standard Letter

MATH 00023 BASIC ALGEBRA III 2 Credit Hours

Course covers zeros of functions, rational expressions and equations, problem-solving with rational expressions, intermediate factoring techniques. Quadratics: functions, graphs, equations, inequalities, "quadratic type" equations and problem-solving. Course does not count toward graduation.

Prerequisite: Minimum 35 ALEKS math score; or minimum C grade in MATH 00022.

Schedule Type: Emporium

Contact Hours: 2 other

Grade Mode: Standard Letter

MATH 00024 BASIC ALGEBRA IV 2 Credit Hours

Course covers advanced factoring techniques, rational functions, radical equations, absolute value equations and inequalities. Exponential and logarithmic functions: introduction, graphing, problem-solving. Course does not count toward graduation.

Prerequisite: Minimum 45 ALEKS math score; or minimum C grade in MATH 00023.

Schedule Type: Emporium

Contact Hours: 2 other

Grade Mode: Standard Letter

MATH 00095 SPECIAL TOPICS IN MATHEMATICS 1-4 Credit Hours
(Repeatable for credit) Topics in mathematics not covered in regular courses. Offered when opportunities and resources permit; the topic is announced when the course is scheduled. Course does not count toward graduation.

Prerequisite: None.

Schedule Type: Emporium

Contact Hours: 1-4 other

Grade Mode: Standard Letter

MATH 10041 INTRODUCTORY STATISTICS (KMCR) 4 Credit Hours
An introduction to statistical thinking and statistical methods. Emphasis is on statistical literacy, conceptual understanding and active learning in the classroom.

Prerequisite: Minimum 35 ALEKS math score; or minimum 22 ACT math score; or minimum 530 SAT math score; or minimum C grade in MATH 00022, MATH 00023 or MATH 00024; or any course MATH 10033 to MATH 49999.

Schedule Type: Emporium

Contact Hours: 4 other

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 10051 QUANTITATIVE REASONING (KMCR) 4 Credit Hours
In the broadest sense, mathematics should provide students the needed quantitative tools, logical reasoning and problem solving skills, and a sense that quantitative modeling can be used to describe and understand developments in many areas of daily living. Since critical thinking is the primary objective and outcome for this course, in each area of concentration (numeracy, mathematical modeling and probability and statistics), students will read and glean information from the problem situation, convert the information into a usable form, perform any needed routine calculations, make or draw a conclusion, and then communicate the result via explanation using quantitative reasoning by writing coherent statements and paragraphs.

Prerequisite: Minimum 35 ALEKS math score; or minimum 22 ACT math score; or minimum 530 SAT math score; or minimum C grade in MATH 00022; or any course MATH 00023 to MATH 49999.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 10771 BASIC MATHEMATICAL CONCEPTS I PLUS (KMCR) 5 Credit Hours

(Equivalent to MATH 14001) Course covers the development of the real-number system and its sub-systems, open sentences, numeration systems, modular arithmetic and some number theory concepts.

Additional concepts covered include place value, logic, sets, algebra concepts and problem solving.

Prerequisite: Minimum 35 ALEKS math score; or minimum 22 ACT math score; or minimum 530 SAT math score; or minimum C grade in MATH 00022.

Schedule Type: Lecture

Contact Hours: 5 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 10772 MODELING ALGEBRA PLUS (KMCR) 5 Credit Hours
(Equivalent to MATH 11009) Study of algebra arising in the context of real-world applications, including linear, polynomial, exponential and logarithmic models. Includes a review of factoring and functions. Course is intended for students not planning to take calculus. No credit earned for this course if student already earned credit for MATH 11010.

Prerequisite: Minimum 35 ALEKS math score; or minimum 22 ACT math score; or minimum 530 SAT math score; or minimum C grade in MATH 00022.

Schedule Type: Lecture

Contact Hours: 5 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 10773 ALGEBRA FOR CALCULUS STRETCH I 3 Credit Hours
Study of functions in general, factoring, negative and rational exponents; polynomial functions, including quadratic functions; and sequences and series. No credit earned for this course if a student already earned credit for MATH 12001. Students cannot earn credit toward a degree for both this course and either MATH 10775 or MATH 11010.

Prerequisite: Minimum 35 ALEKS math score; or minimum 22 ACT math score; or minimum 530 SAT math score; or minimum C grade in MATH 00022.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 10774 ALGEBRA FOR CALCULUS STRETCH II (KMCR) 3 Credit Hours

(Equivalent to MATH 10775 or MATH 11010) Course is continuation of MATH 10773. Study of rational expressions and functions, exponential and logarithmic functions and conic sections. No credit earned for this course if student already earned credit for MATH 12001.

Prerequisite: Minimum C grade in MATH 10773.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 10775 ALGEBRA FOR CALCULUS PLUS (KMCR) 4 Credit Hours

(Equivalent to MATH 10774 or MATH 11010) Study of elementary functions and graphs, including polynomial, exponential and logarithmic functions, complex numbers; conic sections; arithmetic and geometric sequences. In addition, factoring, negative and rational exponents, and quadratic functions are covered. No credit earned for this course if student has already earned credit for MATH 12001.

Prerequisite: Minimum 45 ALEKS score; or minimum C grade in MATH 00023.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 11008 EXPLORATIONS IN MODERN MATHEMATICS (KMCR) 3 Credit Hours

Topics from various branches of mathematics will be chosen to introduce the student to the wide varieties of ways in which mathematics affects everyday life.

Prerequisite: Minimum 35 ALEKS math score; or minimum 22 ACT math score; or minimum C grade in MATH 00022; or any course MATH 00023 to MATH 49999.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 11009 MODELING ALGEBRA (KMCR) 4 Credit Hours

(Equivalent to MATH 10772) Study of algebra arising in the context of real-world applications, including linear, polynomial, exponential and logarithmic models. Intended for students not planning to take calculus. No credit earned toward a degree for this course if the student already earned credit for MATH 11010.

Prerequisite: Minimum 45 ALEKS math score or minimum C grade in MATH 00023.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 11010 ALGEBRA FOR CALCULUS (KMCR) 3 Credit Hours

(Equivalent to MATH 10774 and MATH 10775) Study of elementary functions and graphs, including polynomial, exponential and logarithmic functions, complex numbers; conic sections; arithmetic and geometric sequences. No credit earned toward a degree for this course if the student already earned credit for MATH 10773 or MATH 12001.

Prerequisite: Minimum 55 ALEKS math score; or minimum C grade in MATH 00024 or MATH 10772 or MATH 11009.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 11012 INTUITIVE CALCULUS (KMCR) 3 Credit Hours

Designed to give an overview of differential and integral calculus to business and life-science majors. Does not include trigonometric functions. No credit earned toward a degree for this course if the student already earned credit for MATH 12002.

Prerequisite: Minimum 67 ALEKS math score; or minimum C grade in MATH 10774 or MATH 10775 or MATH 11010.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 11022 TRIGONOMETRY (KMCR) 3 Credit Hours

Solution of triangles, trigonometric equations and identities.

Prerequisite: Minimum 67 ALEKS math score; or minimum C grade in MATH 10774 or MATH 10775 or MATH 11010.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 12001 ALGEBRA AND TRIGONOMETRY (KMCR) 5 Credit Hours

Introduction to algebra and trigonometry including functions and graphs; polynomial and rational functions; exponential and logarithmic functions; angles and the trigonometric functions; graphs of trigonometric functions; trigonometric identities; inverse circular functions and trigonometric equations; and applications of trigonometry. No credit earned toward a degree for this course if the student already earned credit for MATH 10774 or MATH 10775 or MATH 11010 or MATH 11022.

Prerequisite: Minimum 67 ALEKS math score; or minimum B grade in MATH 00024.

Schedule Type: Lecture

Contact Hours: 5 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 12002 ANALYTIC GEOMETRY AND CALCULUS I (KMCR) 5 Credit Hours

Concepts of limit, continuity and derivative, and the indefinite and definite integral for functions of one real variable. Maximization, related rates, fundamental theorem of calculus. No credit earned toward a degree for this course if the student already earned credit for MATH 12011 and MATH 12012.

Prerequisite: Minimum 78 ALEKS math score; or minimum C grade in MATH 11022 or MATH 12001.

Schedule Type: Lecture

Contact Hours: 5 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 12003 ANALYTIC GEOMETRY AND CALCULUS II 5 Credit Hours

Continued study of techniques and applications of integration; trigonometric, logarithmic and exponential functions; polar coordinates; vectors; parametric equations; sequences and series.

Prerequisite: Minimum C grade in MATH 12002 or MATH 12012.

Schedule Type: Lecture

Contact Hours: 5 lecture

Grade Mode: Standard Letter

Attributes: Transfer Module Mathematics

MATH 12011 CALCULUS WITH PRECALCULUS I (KMCR) 3 Credit Hours

Introduction to differential calculus with a review of algebra and trigonometry. Includes exponents, factoring, functions, graphs, tangent lines, limits, continuity, derivatives and related rates. No credit earned toward a degree for this course if the student already earned credit for MATH 12002.

Prerequisite: Minimum 67 ALEKS math score.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 12012 CALCULUS WITH PRECALCULUS II (KMCR) 3 Credit Hours

Development of integral calculus and continued study of differential calculus. Includes curve sketching optimization fundamental theorem of calculus areas between curves, exponential and logarithmic functions. No credit earned toward a degree for this course if student already earned credit for MATH 12002.

Prerequisite: Minimum C grade in MATH 12011.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning, Transfer Module Mathematics

MATH 12021 CALCULUS FOR LIFE SCIENCES 4 Credit Hours

Differential and integral calculus using examples and problems in life sciences.

Prerequisite: Minimum 78 ALEKS math score; or minimum C grade in MATH 11022 or MATH 12011.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 12022 PROBABILITY AND STATISTICS FOR LIFE SCIENCES 3 Credit Hours

Probability and statistics with applications in medical and biological sciences.

Prerequisite: Minimum C grade in MATH 12002 or MATH 12012 or MATH 12021.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 14001 BASIC MATHEMATICAL CONCEPTS I (KMCR) 4 Credit Hours

(Equivalent to MATH 10771) Development of the real number system and its sub-systems, open sentences, numeration systems, modular arithmetic and some number theory concepts.

Prerequisite: Minimum 45 ALEKS math score; or minimum C grade in MATH 00023 or any higher MATH course (except MATH 10041, MATH 10051 or MATH 11008).

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 14002 BASIC MATHEMATICAL CONCEPTS II (KMCR) 4 Credit Hours

Basic concepts of probability, statistics and geometry.

Prerequisite: Minimum C grade in MATH 10771 or MATH 14001.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

Attributes: Kent Core Mathematics and Critical Reasoning

MATH 19002 TECHNICAL MATHEMATICS II 4 Credit Hours

Continuation of MATH 19001. Emphasizes advanced topics in algebra and trigonometry, analytic geometry, derivatives and integrals.

Prerequisite: None.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 19099 FIELD EXPERIENCE IN MATHEMATICS INSTRUCTION (ELR) 1 Credit Hour

(Repeatable for credit) Learning through tutoring. A supervised lab experience in providing explanations of mathematical concepts.

Prerequisite: Special approval.

Schedule Type: Lecture

Contact Hours: 1 lecture

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement

MATH 20011 DECISION-MAKING UNDER UNCERTAINTY 3 Credit Hours

An introductory course on applied statistics. The course provides a hands-on approach to understanding, quantification and decision-making under various forms of uncertainty. The main topics include visualization of uncertainty, probabilistic quantification of uncertainty, Bayesian and non-Bayesian ways of decision-making under uncertainty. Class activities incorporate active learning elements, including in-classroom computation with professional-grade software for statistical analysis and simulation.

Prerequisite: Minimum C grade in MATH 12002.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 20095 SPECIAL TOPICS IN MATHEMATICS 1-5 Credit Hours

(Repeatable for credit) Various special courses will be announced in the schedule of classes under this course number with different section numbers.

Prerequisite: Special approval.

Schedule Type: Lecture

Contact Hours: 1-5 lecture

Grade Mode: Standard Letter

MATH 21001 LINEAR ALGEBRA WITH APPLICATIONS 3 Credit Hours

Systems of linear equations and the associated matrix operations, linear transformations, vector spaces, bases, eigenvectors.

Prerequisite: Minimum C grade in MATH 11012 or MATH 12002.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: TAG Mathematics

MATH 21092 COMPUTER PRACTICUM (ELR) 2 Credit Hours

(Repeatable for credit) Supervised work experience in a computer installation.

Prerequisite: None.

Schedule Type: Practicum or Internship

Contact Hours: 2 other

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement

MATH 22005 ANALYTIC GEOMETRY AND CALCULUS III 4 Credit Hours

Study of functions of several variables, including partial derivatives and multiple integrals.

Prerequisite: Minimum C grade in MATH 12003.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 23022 DISCRETE STRUCTURES FOR COMPUTER SCIENCE 3 Credit Hours

(Cross-listed with CS 23022) Discrete structures for computer scientists with a focus on: mathematical reasoning, combinatorial analysis, discrete structures, algorithmic thinking, applications and modeling. Specific topics include logic, sets, functions, relations, algorithms, proof techniques, counting, graphs, trees, Boolean algebra, grammars and languages.

Prerequisite: Minimum 55 Compass Algebra score and either minimum 540 SAT math score or minimum 23 ACT math score; or CS 10051 and minimum C grade in MATH 11010.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 30011 BASIC PROBABILITY AND STATISTICS 3 Credit Hours

Analysis and representation of data. Controlled experiments and observations. Measurement errors. Correlation and regression. Sampling. Probability models and tests of models. Inference. This course CANNOT be used to meet the mathematics requirements for a BA in Mathematics or a BS in Applied Mathematics or Mathematics.

Prerequisite: Minimum 67 ALEKS math score; or minimum C grade in MATH 10774 or MATH 10775 or MATH 11010; or any course MATH 11012 to MATH 12022; or any course MATH 20000 to MATH 49999.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 30055 MATHEMATICAL THEORY OF INTEREST 3 Credit Hours

A calculus-based introduction to the mathematics of finance. Limited to deterministic analysis of interest rates annuities bonds and immunization. Emphasizes the mathematical theory of the subject matter.

Prerequisite: Minimum C grade in MATH 12003.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 31011 PROOFS IN DISCRETE MATHEMATICS 3 Credit Hours

The study of discrete mathematical structures including sets, functions, and relations. The course includes an introduction to logical thinking with an emphasis on proof techniques. The course also emphasizes combinatorics topics such as recursion and counting.

Prerequisite: Minimum C grade in MATH 12002.

Pre/corequisite: Minimum C grade in MATH 21001 or MATH 32051.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 32044 ORDINARY DIFFERENTIAL EQUATIONS 3 Credit Hours

An introduction to ordinary differential equations and applications. Topics include solution methods, series solutions and singular points. Laplace transforms and linear systems. Applications include population dynamics, forced oscillations and resonance.

Prerequisite: Minimum C grade in MATH 21001 and MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: TAG Mathematics

MATH 32051 MATHEMATICAL METHODS IN THE PHYSICAL SCIENCES I 4 Credit Hours

Mathematics background beyond calculus I and II for upper-division courses in the physical sciences. Topics include complex numbers and arithmetic, linear algebra, partial differentiation and multiple integrals.

Prerequisite: Minimum C grade in MATH 12003.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 32052 MATHEMATICAL METHODS IN THE PHYSICAL SCIENCES II 4 Credit Hours

Additional mathematics background for upper-division courses in the physical sciences. Topics include vector analysis, Fourier series and transforms ordinary differential equations and partial differential equations.

Prerequisite: Minimum C grade in MATH 32051; or minimum C grade in MATH 21001 and MATH 22005.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 34001 FUNDAMENTAL CONCEPTS OF ALGEBRA 3 Credit Hours

Professionalized course in algebra for prospective secondary teachers. Postlational development of number system of algebra; other systems, related topics, applications. This course cannot be used to meet the mathematical requirements for a BA in Mathematics or a BS in either Applied Mathematics or Mathematics. Cannot earn credit for this class if credit has already been earned for Math 41001.

Prerequisite: Minimum C grade in MATH 12002.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 34002 FUNDAMENTAL CONCEPTS OF GEOMETRY 3 Credit Hours

Professionalized course in geometry for secondary school teachers. Origin and development of the geometry of Euclid with modern refinements, topics, approaches. Other geometries, applications. This cannot be used to meet the mathematics requirement for a BA in Mathematics or a BS in either Applied Mathematics or Mathematics.

Prerequisite: Minimum C grade in MATH 12002.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 38001 HANDS-ON MATHEMATICS 3 Credit Hours

Students take turns learning a topic and then teach that topic to the class. No text is required; the students use web resources and materials supplied by the instructor. Many of the topics have a hands-on component. Some examples are two- and three-dimensional tiling problems, the Towers of Hanoi and other problems with an inductive solution, and 'magic tricks' with a basis in algebra, parity or modular arithmetic.

Prerequisite: Minimum C grade in MATH 12003.

Schedule Type: Seminar

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40011 PROBABILITY THEORY AND APPLICATIONS 3 Credit Hours

(Slashed with MATH 50011) Permutations and combinations, discrete and continuous distributions, random variables, conditional probabilities, Baye's formula, mathematical expectation, law of large numbers, normal approximations, basic limit theorems.

Prerequisite: Minimum C grade in MATH 22005 or MATH 32051.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40012 THEORY OF STATISTICS 3 Credit Hours

(Slashed with MATH 50012) Sample spaces, continuous distributions, sampling distributions, point and interval estimation, hypothesis testing, types of error, level and power of tests, sequential and nonparametric methods.

Prerequisite: Minimum C grade in MATH 40011.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40015 APPLIED STATISTICS 3 Credit Hours

(Slashed with MATH 50015) Course is based on classical linear regression techniques with an emphasis on real data using the principles of sound data analysis. Close attention is given to issues of interpretation, diagnostics, outliers and influential points, goodness of fit and model selection. Topics include simple and multiple linear regression, transformation and modifications of covariates and responses, design matrices, variable selection and logistic regression.

Prerequisite: Minimum C grade in both MATH 20011 and MATH 21001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40024 COMPUTATIONAL STATISTICS 3 Credit Hours

(Slashed with MATH 50024) This course is about the use of computational tools to manage, explore, summarize, and visualize data, as well as the computational underpinnings of fitting statistical models. It uses mostly the statistical computation language R, but also other languages like Python and Matlab. It also covers: simulation and random number generation, computationally intensive methods like the bootstrap and permutation tests, Expectation-Maximization and related algorithms, and dimensionality reduction via matrix decomposition.

Prerequisite: Minimum grade of C in both MATH 20011 and MATH 21001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40028 STATISTICAL LEARNING 3 Credit Hours

(Slashed with MATH 50028) This course is about the statistical foundations of modern machine learning techniques. The main focus is classification and prediction, using regression-based, tree-based, and kernel-based methods. Specific methods include logistic regression, classification and regression trees, random forests, and support vector machines. The course also includes an introduction to unsupervised and semi-supervised learning.

Prerequisite: Minimum grade of C in both MATH 40015 and MATH 40024.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40051 TOPICS IN PROBABILITY THEORY AND STOCHASTIC PROCESSES 3 Credit Hours

(Slashed with MATH 50051) Topics from conditional expectations, Markov chains, Markov processes, Brownian motion and Martingales and their applications to stochastic calculus.

Prerequisite: Minimum C grade in MATH 40011.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40055 ACTUARIAL MATHEMATICS I (ELR) (WIC) 4 Credit Hours

(Slashed with MATH 50055) Topics from survival models, stochastic analysis of annuities and life insurance and casualty models.

Prerequisite: Minimum C grade in MATH 30055 and MATH 40011.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement, Writing Intensive Course

MATH 40056 ACTUARIAL MATHEMATICS II 4 Credit Hours

(Slashed with MATH 50056) Benefit premiums, benefit reserves and their analysis, decrement models, joint survivorship, risk models.

Prerequisite: Minimum C grade in MATH 40055.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 40059 STOCHASTIC ACTUARIAL MODELS 3 Credit Hours

(Slashed with MATH 50059) Designed to prepare students for the Society of Actuaries examination on actuarial mathematics.

Prerequisite: Minimum C grade in MATH 40011.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 40093 VARIABLE TITLE WORKSHOP IN MATHEMATICS 1-6 Credit Hours

(Repeatable for credit) Studies special topics in mathematics. Not acceptable for credit toward a major or minor in math without approval of student's adviser.

Prerequisite: Special approval.

Schedule Type: Workshop

Contact Hours: 1-6 other

Grade Mode: Satisfactory/Unsatisfactory

MATH 41001 MODERN ALGEBRA I (ELR) (WIC) 3 Credit Hours

(Slashed with MATH 51001) Basic properties of groups, subgroups, factor groups. Basic properties of rings, integral domains and homomorphisms.

Prerequisite: Minimum C grade in MATH 22005 or MATH 32051; and minimum C grade in MATH 31011.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement, Writing Intensive Course

MATH 41002 MODERN ALGEBRA II (ELR) (WIC) 3 Credit Hours

(Slashed with MATH 51002) A continuation of MATH 41001, emphasizing properties of rings, their ideals, polynomial ring extensions, fields, finite degree extensions, roots of polynomials, constructability.

Prerequisite: Minimum C grade in MATH 41001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement, Writing Intensive Course

MATH 41021 THEORY OF MATRICES 3 Credit Hours

(Slashed with MATH 51021) A rigorous study of the topics introduced in matrix algebra. Topics included are vector space preliminaries, canonical forms of matrices, diagonalizability criteria.

Prerequisite: Minimum C grade in MATH 21001 and MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 41038 INTERMEDIATE LOGIC 3 Credit Hours

(Slashed with MATH 51038; Cross-listed with CS 41038 and PHIL 41038 and PHIL 51038) A detailed, systematic study of symbolic logic for philosophy majors, mathematics majors, computer science majors, and anyone else interested in advanced study in logic. The aim of the course is twofold: first, to develop a facility in understanding and using symbolic logic for various purposes, and second, to understand and appreciate symbolic logic as an area of study in itself. Topics include the distinction between syntactic, object-level proofs and semantic, meta-level proofs, the distinction between axiomatic systems and natural deduction systems of object-level proofs, various systems of modal logic, and some non-classical logics.

Prerequisite: None.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 41045 METALOGIC 3 Credit Hours

(Slashed with MATH 51045; Cross-listed with CS 41045 and CS 51045 and PHIL 41045 and PHIL 51045) A detailed, systematic study of metalogic for philosophy majors, mathematics majors, computer science majors, and anyone else interested in advanced study in logic. Topics include the soundness and completeness of the propositional and predicate calculi, the decidability of propositional calculus, the undecidability of predicate calculus, Gödel's incompleteness proof for languages capable of expressing arithmetic, the co-extensionality of the set of general recursive functions, abacus computable functions, and Turing computable functions, and the philosophical motivations for the Church-Turing Thesis that all computable functions are Turing computable.

Prerequisite: PHIL 41038.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42001 ANALYSIS I (ELR) (WIC) 3 Credit Hours

(Slashed with MATH 52001) Topics include basic structure of the real numbers, Cauchy sequences, convergence, completeness of the real numbers, continuity, differentiation and Riemann integration.

Prerequisite: Minimum C grade in MATH 22005 or MATH 32051 and Minimum C grade in MATH 31011.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement, Writing Intensive Course

MATH 42002 ANALYSIS II (ELR) (WIC) 3 Credit Hours

(Slashed with MATH 52002) Topics include further development of integration theory, infinite series, uniform convergence, several variable calculus and metric spaces.

Prerequisite: Minimum C grade in MATH 42001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

Attributes: Experiential Learning Requirement, Writing Intensive Course

MATH 42011 MATHEMATICAL OPTIMIZATION 3 Credit Hours

(Slashed with MATH 52011) Analytic and numerical techniques for location of extreme points of functions and calculus of variations. Both constrained and unconstrained problems are considered.

Prerequisite: Minimum C grade in MATH 21001 and MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42021 GRAPH THEORY AND COMBINATORICS 3 Credit Hours

(Slashed with MATH 52021) Fundamentals and applications of combinatorial mathematics. Topics include traversability, colorability, networks, inclusion and exclusion, matching and designs.

Prerequisite: Minimum C grade in MATH 12003 and MATH 21001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42024 NUMBERS AND GAMES 3 Credit Hours

(Slashed with MATH 52024) The study of partisan and impartial combinatorial games; games as numbers; Grundy-Sprague theory.

Prerequisite: Minimum C grade in MATH 21001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42031 MATHEMATICAL MODELS AND DYNAMICAL SYSTEMS 3 Credit Hours

(Slashed with MATH 52031) Formulation and analysis of mathematical models for a variety of phenomena. Mathematical methods from optimization dynamical systems and probability are developed and applied. Modern software tools are utilized.

Prerequisite: Minimum C grade in MATH 32044 or MATH 32052.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42039 MODELING PROJECTS (ELR) (WIC) 3 Credit Hours

(Slashed with MATH 52039) Individual and small-group projects concerned with the formulation and analysis of mathematical models in a variety of areas. Written and oral reports are required.

Prerequisite: Minimum C grade in MATH 42031.

Schedule Type: Seminar

Contact Hours: 3 other

Grade Mode: Standard Letter-IP

Attributes: Experiential Learning Requirement, Writing Intensive Course

MATH 42041 ADVANCED CALCULUS 3 Credit Hours

(Slashed with MATH 52041) The calculus and applications of scalar and vector functions of several variables. Vector differential and integral calculus. Applications to field theories, electricity and magnetism and fluid flow.

Prerequisite: Minimum C grade in MATH 21001 and MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42045 PARTIAL DIFFERENTIAL EQUATIONS 3 Credit Hours

(Slashed with MATH 52045) An introduction to Fourier series, Fourier transforms and partial differential equations. Wave, heat and potential equations of mathematical physics. Additional topics include Green's functions and the Method of Characteristics for wave equations.

Prerequisite: Minimum C grade in MATH 32044.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42048 COMPLEX VARIABLES 3 Credit Hours

(Slashed with MATH 52048) Algebra of complex numbers, analytic functions, mappings, Cauchy integral theory, residue theory and applications.

Prerequisite: Minimum C grade in MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42201 NUMERICAL COMPUTING I 3 Credit Hours

(Cross-listed with CS 42201 and CS 52201; slashed with MATH 52201). An introduction to numerical methods and software for solving many common scientific computing problems. Linear systems, least-squares data fitting, nonlinear equations and systems, and optimization problems.

Prerequisite: Minimum C grade in all the following: MATH 12003; and MATH 21001 or MATH 32051; and CS 10061 or CS 13001 or (CS 13011 and CS 13012).

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 42202 NUMERICAL COMPUTING II 3 Credit Hours

(Cross-listed with CS 42202; slashed with CS 52202 and MATH 52202) A continuation of MATH 42201. Topics include interpolation, numerical differentiation and integration, and numerical solution of ordinary differential equations.

Prerequisite: Minimum C grade in MATH 42201; and minimum C grade in MATH 32044 or MATH 32052.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 45011 DIFFERENTIAL GEOMETRY 3 Credit Hours

(Slashed with MATH 55011) Analytic and metric differential geometry of curves and surfaces.

Prerequisite: Minimum C grade in MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 45021 EUCLIDEAN GEOMETRY 3 Credit Hours

(Slashed with MATH 55021) Geometry of Euclid extended to advanced topics of the triangle, quadrilaterals and circles: cross-ratio, groups, constructions, geometric generalizations; inversion.

Prerequisite: Minimum C grade in MATH 21001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 45022 LINEAR GEOMETRY 3 Credit Hours

(Slashed with MATH 55022) Using transformations as a tool to study geometry and to differentiate between different kinds of geometry. Linear algebra methods applied to geometry.

Prerequisite: Minimum C grade in MATH 21001.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 46001 ELEMENTARY TOPOLOGY 3 Credit Hours

(Slashed with MATH 56001) Metric spaces, introduction to topological spaces, separation axioms.

Prerequisite: Minimum C grade in MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 47011 THEORY OF NUMBERS 3 Credit Hours

(Slashed with MATH 57011) Divisibility properties of the integers, prime numbers, congruences, quadratic reciprocity, Diophantine equations, number theoretic functions, simple continued fractions, rational approximations.

Prerequisite: Minimum C grade in MATH 12003.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 47021 HISTORY OF MATHEMATICS 3 Credit Hours

(Slashed with MATH 57021) Survey from Babylonian and Egyptian mathematics to 20th century mathematics with emphasis on the development of algebra, geometry, calculus, number theory.

Prerequisite: Minimum C grade in one course MATH 23022 or higher.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 49995 SELECTED TOPICS IN MATHEMATICS AND ITS APPLICATIONS 1-4 Credit Hours

(Repeatable for credit) Various special courses will be announced in the schedule of classes under this course number with different section numbers.

Prerequisite: Special approval.

Schedule Type: Lecture

Contact Hours: 1-4 lecture

Grade Mode: Standard Letter

MATH 49996 INDIVIDUAL STUDY 1-4 Credit Hours

(Repeatable for credit) Individual investigation in mathematics.

Prerequisite: Special approval.

Schedule Type: Individual Investigation

Contact Hours: 1-4 other

Grade Mode: Standard Letter

MATH 49998 RESEARCH (ELR) 1-15 Credit Hours

(Repeatable for credit) Research in mathematics.

Prerequisite: Special approval.

Schedule Type: Research

Contact Hours: 1-15 other

Grade Mode: Satisfactory/Unsatisfactory-IP

Attributes: Experiential Learning Requirement

MATH 50011 PROBABILITY THEORY AND APPLICATIONS 3 Credit Hours

(Slashed with MATH 40011) Permutations and combinations, discrete and continuous distributions, random variables, conditional probabilities, Baye's formula, mathematical expectation, law of large numbers, normal approximations, basic limit theorems.

Prerequisite: Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 50012 THEORY OF STATISTICS 3 Credit Hours

(Slashed with MATH 40012) Sample spaces, continuous distributions, sampling distributions, point and interval estimation, hypothesis testing, types of error, level and power of tests, sequential and nonparametric methods.

Prerequisite: MATH 40011 or MATH 50011; and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 50015 APPLIED STATISTICS 3 Credit Hours

Slashed with MATH 40015) Course is based on classical linear regression techniques with an emphasis on real data using the principles of sound data analysis. Close attention is given to issues of interpretation, diagnostics, outliers and influential points, goodness of fit and model selection. Topics include simple and multiple linear regression, transformation and modifications of covariates and responses, design matrices, variable selection and logistic regression.

Prerequisite: Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 50024 COMPUTATIONAL STATISTICS 3 Credit Hours

(Slashed with MATH 40024) This course is about the use of computational tools to manage, explore, summarize, and visualize data, as well as the computational underpinnings of fitting statistical models. It uses mostly the statistical computation language R, but also other languages like Python and Matlab. It also covers: simulation and random number generation, computationally intensive methods like the bootstrap and permutation tests, Expectation-Maximization and related algorithms, and dimensionality reduction via matrix decomposition.

Prerequisite: Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 50028 STATISTICAL LEARNING 3 Credit Hours

(Slashed with MATH 40028) This course is about the statistical foundations of modern machine learning techniques. The main focus is classification and prediction, using regression-based, tree-based, and kernel-based methods. Specific methods include logistic regression, classification and regression trees, random forests, and support vector machines. The course also includes an introduction to unsupervised and semi-supervised learning.

Prerequisite: MATH 40015 or 50015 and MATH 40024 or 50024 and Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 50051 TOPICS IN PROBABILITY THEORY AND STOCHASTIC PROCESSES 3 Credit Hours

(Slashed with MATH 40051) Topics from conditional expectations, Markov chains, Markov processes, Brownian Motion and Martingales and their applications to stochastic calculus.

Prerequisite: MATH 50011 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 50055 ACTUARIAL MATHEMATICS I 4 Credit Hours

(Slashed with MATH 40055) Topics from survival models, stochastic analysis of annuities and life insurance and casualty models.

Prerequisite: MATH 30055 and MATH 50011; and Graduate standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 50056 ACTUARIAL MATHEMATICS II 4 Credit Hours

(Slashed with MATH 40056) Benefit premiums, benefit reserves and their analysis; decrement models, joint survivorship, risk models.

Prerequisite: MATH 50055 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 50059 STOCHASTIC ACTUARIAL MODELS 3 Credit Hours

(Slashed with MATH 40059) Designed to prepare students for the Society of Actuaries examination on actuarial mathematics.

Prerequisite: Minimum C grade in MATH 50011 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 51001 MODERN ALGEBRA I 3 Credit Hours

(Slashed with MATH 41001) Basic properties of groups, subgroups, factor groups. Basic properties of rings, integral domains and homomorphisms.

Prerequisite: MATH 21001 and MATH 22005 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 51002 MODERN ALGEBRA II 3 Credit Hours

(Slashed with MATH 41002) A continuation of MATH 51001, emphasizing properties of rings, their ideals, polynomial ring extensions, fields, finite degree extensions, roots of polynomials, constructibility.

Prerequisite: MATH 41001 or MATH 51001; Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 51021 THEORY OF MATRICES 3 Credit Hours

(Slashed with MATH 41021) A rigorous study of the topics introduced in matrix algebra. Topics included are: canonical forms of matrices, diagonalizability criteria.

Prerequisite: MATH 21001 and MATH 22005 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 51038 INTERMEDIATE LOGIC 3 Credit Hours

(Cross-listed with CS 41038 and PHIL 41038 and PHIL 51038; slashed with MATH 41038) A detailed, systematic study of symbolic logic for philosophy majors, mathematics majors, computer science majors, and anyone else interested in advanced study in logic. The aim of the course is twofold: first, to develop a facility in understanding and using symbolic logic for various purposes, and second, to understand and appreciate symbolic logic as an area of study in itself. Topics include the distinction between syntactic, object-level proofs and semantic, meta-level proofs, the distinction between axiomatic systems and natural deduction systems of object-level proofs, various systems of modal logic and some non-classical logics.

Prerequisite: Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 51045 METALOGIC 3 Credit Hours

(Cross-listed with CS 41045 and CS 51045 and PHIL 41045 and PHIL 51045; slashed with MATH 41045) A detailed, systematic study of metalogic for philosophy majors, mathematics majors, computer science majors, and anyone else interested in advanced study in logic. Topics include the soundness and completeness of the propositional and predicate calculi, the decidability of propositional calculus, the undecidability of predicate calculus, Gödel's incompleteness proof for languages capable of expressing arithmetic, the co-extensionality of the set of general recursive functions, abacus computable functions, and Turing computable functions, and the philosophical motivations for the Church-Turing Thesis that all computable functions are Turing computable.

Prerequisite: Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52001 ANALYSIS I 3 Credit Hours

(Slashed with MATH 42001) Topics include basic structure of the real numbers, Cauchy sequences, convergence, completeness of the real numbers, continuity, differentiation and Riemann integration.

Prerequisite: Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52002 ANALYSIS II 3 Credit Hours

(Slashed with MATH 42002) Topics include further development of integration theory infinite series, uniform convergence, several variable calculus and metric spaces.

Prerequisite: MATH 42001 or MATH 52001; and Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52011 MATHEMATICAL OPTIMIZATION 3 Credit Hours

(Slashed with MATH 42011) Analytical and numerical techniques for location of extreme points of functions and calculus of variations. Both constrained and unconstrained problems are considered.

Prerequisite: MATH 21001 and MATH 22005; Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52021 GRAPH THEORY AND COMBINATORICS 3 Credit Hours

(MATH 42021) Fundamentals and applications of combinatorial mathematics. Topics include transversability, colorability, networks, inclusion and exclusion, matching and designs.

Prerequisite: MATH 12003 and MATH 21001 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52024 NUMBERS AND GAMES 3 Credit Hours

(Slashed with MATH 42024) The study of partisan and impartial combinatorial games; games as numbers; Grundy-Sprague theory.

Prerequisite: Special approval and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52031 MATHEMATICAL MODELS AND DYNAMICAL SYSTEMS 3 Credit Hours

(Slashed with MATH 42031) Formulation and analysis of mathematical models for a variety of phenomena. Mathematical methods from optimization, dynamical systems and probability are developed and applied. Modern software tools are utilized.

Prerequisite: MATH 32044 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52039 MODELING PROJECTS 3 Credit Hours

(Slashed with MATH 42039) Individual and small-group projects concerned with the formulation and analysis of mathematical models in a variety of areas. Written and oral reports required.

Prerequisite: Minimum C grade in MATH 52031; and Graduate standing.

Schedule Type: Seminar

Contact Hours: 3 other

Grade Mode: Standard Letter-S/U-IP

MATH 52041 ADVANCED CALCULUS 3 Credit Hours

(Slashed with MATH 42041) The calculus and applications of scalar and vector functions of several variables. Vector differential and integral calculus. Applications to field theories, electricity and magnetism and fluid flow.

Prerequisite: MATH 21001 and MATH 22005.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52045 PARTIAL DIFFERENTIAL EQUATIONS 3 Credit Hours

(Slashed with MATH 42045) Introduction to Fourier series, Fourier transforms and partial differential equations. Wave, heat and potential equations of mathematical physics. Additional topics include Green's functions and the Method of Characteristics for wave equations.

Prerequisite: Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52048 COMPLEX VARIABLES 3 Credit Hours

(Slashed with MATH 42048) Algebra of complex numbers, analytic functions, mappings, Cauchy integral theory, residue theory and applications.

Prerequisite: Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52201 NUMERICAL COMPUTING I 3 Credit Hours

(Cross-listed with CS 42201 and CS 52201; slashed with MATH 42201)

An introduction to numerical methods and software for solving many common scientific computing problems. Linear systems, least-square data fitting, nonlinear equations and systems and optimization problems.

Prerequisite: Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 52202 NUMERICAL COMPUTING II 3 Credit Hours

(Cross-listed with CS 42202 and CS 52202; slashed with MATH 42202)

A continuation of MATH 52201. Topics include interpolation, numerical differentiation and integration, and numerical solution of ordinary differential equations.

Prerequisite: MATH 42201 or 52201 and Graduate standing; and declared major in Applied Mathematics or Pure Mathematics.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 55011 DIFFERENTIAL GEOMETRY 3 Credit Hours

(Slashed with MATH 45011) Analytic and metric differential geometry of curves and surfaces.

Prerequisite: MATH 22005 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 55021 EUCLIDEAN GEOMETRY 3 Credit Hours

(Slashed with MATH 45021) Geometry of Euclid extended to advanced topics of the triangle, quadrilaterals and circles: crossratio, groups, constructions, geometric generalizations; inversion.

Prerequisite: MATH 21001 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 55022 LINEAR GEOMETRY 3 Credit Hours

(Slashed with MATH 45022) Use of transformations as a tool to study geometry and to differentiate between different kinds of geometry. Linear algebra methods applied to geometry.

Prerequisite: MATH 21001 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 56001 ELEMENTARY TOPOLOGY 3 Credit Hours

(Slashed with MATH 46001) Metric spaces, introduction to topological spaces, separation axioms.

Prerequisite: MATH 22005 and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 57011 THEORY OF NUMBERS 3 Credit Hours

(Slashed with MATH 47011) Divisibility properties of the integers, prime numbers, congruences, quadratic reciprocity, Diophantine equations, number theoretic functions, simple continued fractions, rational approximations.

Prerequisite: MATH 12003 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 57021 HISTORY OF MATHEMATICS 3 Credit Hours

(Slashed with MATH 47021) Survey from Babylonian and Egyptian mathematics to 20th-century mathematics with emphasis on the development of algebra, geometry, calculus, number theory.

Prerequisite: one course MATH 23022 or higher and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 57091 SELECTED TOPICS IN MATHEMATICS AND ITS APPLICATIONS 1-3 Credit Hours

(Repeatable for credit) Various special courses will be announced in the schedule of classes under this course number with different section numbers.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter

MATH 59893 VARIABLE TITLE WORKSHOP IN MATHEMATICS 1-6 Credit Hours

(Repeatable for credit) Studies in special topics in pure and applied mathematics.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Workshop

Contact Hours: 1-6 other

Grade Mode: Satisfactory/Unsatisfactory

MATH 60051 PROBABILITY I 4 Credit Hours

(Slashed with MATH 70051) Distribution functions, measure theory, random variables, expectation, independence, convergence, concepts, law of large numbers.

Prerequisite: MATH 40011 or MATH 42002 or MATH 50011 or MATH 52002; and Graduate standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 60052 PROBABILITY II 3 Credit Hours

(Slashed with MATH 70052) Characteristic functions, the central limit problem, conditional expectations, Martingale theory, Brownian motion.

Prerequisite: MATH 60051 and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 60061 MATHEMATICAL STATISTICS I 4 Credit Hours

(Slashed with MATH 70061) Statistics, distributions of statistics. Sampling distributions. Decision spaces and loss functions. Sufficiency and completeness. Estimation theory. Rao Blackwell and the Cramer Rao theorems.

Prerequisite: MATH 42002 or MATH 52002; and graduate standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 60062 MATHEMATICAL STATISTICS II 3 Credit Hours
 (Slashed with MATH 70062) Tests of statistical hypothesis. Neyman Pearson Lemma. Exponential families and invariance. Sequential tests. Non-parametric procedures.
Prerequisite: MATH 60061 and graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

MATH 60070 FINANCIAL MATHEMATICS 3 Credit Hours
 (Slashed with MATH 70070) Topics from replication of trading strategies, arbitrage, completeness, Martingale representation theorem, fundamental theorem of finance, stochastic differential equations, Black and Scholes formula of option pricing.
Prerequisite: MATH 50051 and graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

MATH 60091 SEMINAR IN STATISTICS AND PROBABILITY 1-3 Credit Hours
 (Repeatable for credit) Seminar on current research in statistics and probability.
Prerequisite: Special approval and Graduate standing.
Schedule Type: Seminar
Contact Hours: 1-3 other
Grade Mode: Standard Letter-S/U

MATH 60093 VARIABLE TITLE WORKSHOP IN MATHEMATICS 1-3 Credit Hours
 (Repeatable for credit) Studies of special topics in mathematics. Not acceptable for credit toward a graduate degree in mathematics without approval of the student's adviser.
Prerequisite: Special approval and Graduate standing.
Schedule Type: Workshop
Contact Hours: 1-3 other
Grade Mode: Satisfactory/Unsatisfactory

MATH 60094 COLLEGE TEACHING OF MATHEMATICS 1 Credit Hour
 (Repeatable for credit) Techniques and problems in the teaching of college-level mathematics. Student presentations of mathematical papers and colloquia will be included.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 1 lecture
Grade Mode: Standard Letter

MATH 61051 ABSTRACT ALGEBRA I 4 Credit Hours
 (Slashed with MATH 71061) Advanced topics in group theory including Sylow Theorems, finite Abelian groups, divisible groups and related concepts. Includes one hour problem session each week.
Prerequisite: Special approval and graduate standing.
Schedule Type: Lecture
Contact Hours: 4 lecture
Grade Mode: Standard Letter

MATH 61052 ABSTRACT ALGEBRA II 3 Credit Hours
 (Slashed with MATH 71052) Advanced topics, commutative ring theory and field theory, including polynomial rings, unique factorization domains, matrix rings, Galois theory.
Prerequisite: MATH 61051 and graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

MATH 61091 SEMINAR IN ALGEBRA 1-3 Credit Hours
 (Repeatable for credit) Seminar on current research in algebra.
Prerequisite: Special approval and Graduate standing.
Schedule Type: Seminar
Contact Hours: 1-3 other
Grade Mode: Standard Letter-S/U

MATH 62041 METHODS OF APPLIED MATHEMATICS I 3 Credit Hours
 (Slashed with MATH 72041) Analysis and applications of ordinary and partial differential equations and related topics. Dimensional analysis (Buckingham Pi Theorem). Perturbation methods (singular perturbations, matched asymptotic expansions, WKB approximation). Variational methods (Euler-Lagrange equations).
Prerequisite: MATH 51021 and MATH 52041 and MATH 52045 and MATH 52048 and graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

MATH 62042 METHODS OF APPLIED MATHEMATICS II 3 Credit Hours
 (Slashed with MATH 72042) Continuation of MATH 62041. Integral equations and Green's functions (Fredholm alternative, compact operators, distributions, weak solutions). Wave phenomena (dispersion, KdV equation). Stability and bifurcation (linearized stability analysis, turning points, Hopf bifurcation).
Prerequisite: MATH 62041 and graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

MATH 62051 FUNCTIONS OF A REAL VARIABLE I 4 Credit Hours
 (Slashed with MATH 72051) Introduction to modern concepts of real analysis, including metric spaces, measure and integration theory.
Prerequisite: MATH 42002 or MATH 52002; and graduate standing.
Schedule Type: Lecture
Contact Hours: 4 lecture
Grade Mode: Standard Letter

MATH 62052 FUNCTIONS OF A REAL VARIABLE II 3 Credit Hours
 (Slashed with MATH 72052) A continuation of MATH 62051. Included are basic topics in functional analysis and Hilbert space theory.
Prerequisite: MATH 62051 and graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

MATH 62091 SEMINAR IN REAL ANALYSIS 1-3 Credit Hours
Schedule Type: Seminar
Contact Hours: 1-3 other
Grade Mode: Standard Letter-S/U

MATH 62151 FUNCTIONS OF A COMPLEX VARIABLE I 4 Credit Hours
 (Slashed with MATH 72151) Topological properties of the complex plane; analytic, entire, meromorphic functions; analytic continuation; conformal mappings; Picard's Theorem; Riemann surfaces.
Prerequisite: MATH 52002 and graduate standing.
Schedule Type: Lecture
Contact Hours: 4 lecture
Grade Mode: Standard Letter

MATH 62152 FUNCTIONS OF A COMPLEX VARIABLE II 3 Credit Hours

(Slashed with MATH 72152) Topological properties of the complex plane; analytic, entire, meromorphic functions; analytic continuation; conformal mappings; Picard's Theorem; Riemann surfaces.

Prerequisite: MATH 62151 and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62191 SEMINAR IN COMPLEX ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in complex analysis.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 62203 COMPUTATIONAL FINANCE 3 Credit Hours

(Slashed with MATH 72203) Basic numerical methods, (numerical linear algebra, nonlinear equations, curve fitting, ODEs, integration, Monte-Carlo methods), numerical solution of PDEs (stability, convergence, Black-Scholes, American options, SDEs) probabilistic methods.

Prerequisite: MATH 22005 and MATH 21001 and MATH 32044 and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62251 NUMERICAL ANALYSIS I 4 Credit Hours

(Slashed with MATH 72251) Floating point computation, rounding error analysis, conditioning, interpolation (polynomial, trigonometric, spline). Numerical quadrature (Newton-Cotes, Gauss), extrapolation, Romberg integration.

Prerequisite: MATH 42002 or MATH 52002; and graduate standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 62252 NUMERICAL ANALYSIS II 3 Credit Hours

(Slashed with MATH 72252) Numerical solution of linear systems of equations (LU factorization, error analysis). Least squares, orthogonalization methods. Algebraic eigenvalue problems, QR algorithm, singular value decomposition.

Prerequisite: MATH 41021 or MATH 51021; and MATH 62251 or MATH 72251; and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62261 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 3 Credit Hours

(Slashed with MATH 72261) Discretization methods for ordinary differential equations and systems. Initial value and boundary value problems. Numerical implementation software and analysis.

Prerequisite: MATH 32044; and MATH 42202 or MATH 52202; and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62262 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 3 Credit Hours

(Slashed with MATH 72262) Derivation and analysis of discrete methods (finite differences, finite elements) for the numerical solution of elliptic, hyperbolic and parabolic partial differential equations.

Prerequisite: MATH 42045 or MATH 52045; and MATH 42202 or MATH 52202; and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62263 NUMERICAL SOLUTION OF LARGE SPARSE LINEAR SYSTEMS 3 Credit Hours

(Slashed with MATH 72263) (Cross-listed with CS 62263 and CS 72263) Construction and analysis of iterative methods for large systems of linear algebraic equations. Jacobi, Gauss-Seidel, SOR. Polynomial acceleration methods, conjugate gradients. Multi-grid methods.

Prerequisite: MATH 41021 or MATH 51021; and MATH 42202 or MATH 52202; and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62264 NUMERICAL SOLUTION OF NONLINEAR SYSTEMS 3 Credit Hours

(Cross-listed with CS 62264 and CS 72264 and MATH 72264)

Construction and analysis of numerical methods for systems of nonlinear algebraic equations and optimization problems. Numerical implementation and software.

Prerequisite: MATH 42041 or MATH 52041; and MATH 42202 or MATH 52202; and Graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 62291 SEMINAR IN NUMERICAL ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in numerical analysis.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 3 other

Grade Mode: Standard Letter-S/U

MATH 62391 SEMINAR IN MEASURE THEORY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in measure theory.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 62491 SEMINAR IN NONLINEAR ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in nonlinear analysis.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 62591 SEMINAR IN OPERATOR THEORY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in operator theory.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 62691 SEMINAR IN HARMONIC ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in harmonic analysis.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 63291 SEMINAR IN APPLIED MATHEMATICS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in applied mathematics.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 64091 SEMINAR IN MATHEMATICS EDUCATION 3 Credit Hours

(Repeatable for credit) Studies in geometry, algebra, mathematics for junior and senior high school. Mathematics content professionalized for teachers.

Prerequisite: MATH 34001 and Graduate standing.

Schedule Type: Seminar

Contact Hours: 3 other

Grade Mode: Standard Letter

MATH 66051 INTRODUCTION TO TOPOLOGY I 4 Credit Hours

(Slashed with MATH 76051) Set theory, topological spaces, continuity, product spaces, quotient spaces, separation axioms, compactness and metrizable.

Prerequisite: Special approval and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 66052 INTRODUCTION TO TOPOLOGY II 3 Credit Hours

(Slashed with MATH 76052) Geometric topology, including connectedness, continua, homotopy, the plane and 2 manifolds.

Prerequisite: MATH 76051 and graduate standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 66091 SEMINAR IN TOPOLOGY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in topology.

Prerequisite: Special approval and Graduate standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 67091 SEMINAR IN NUMBER THEORY 1-3 Credit Hours

(Repeatable for credit) (Slashed with MATH 77091) Seminar on current research in number theory.

Prerequisite: Graduate standing and special approval.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 67098 RESEARCH 1-15 Credit Hours

(Repeatable for credit) Research or individual investigation. Credits are applied toward degree requirements with approval if letter grade of "S" is given.

Prerequisite: Graduate standing.

Schedule Type: Research

Contact Hours: 1-15 other

Grade Mode: Standard Letter-S/U

MATH 67199 THESIS I 2-6 Credit Hours

Thesis student must register for a total of 6 hours, 2 to 6 hours in a single semester distributed over several semesters if desired.

Prerequisite: Graduate standing.

Schedule Type: Masters Thesis

Contact Hours: 2-6 other

Grade Mode: Satisfactory/Unsatisfactory-IP

MATH 67299 THESIS II 2 Credit Hours

Thesis students must continue registration each semester until all degree requirements are met.

Prerequisite: MATH 67199 and Graduate standing.

Schedule Type: Masters Thesis

Contact Hours: 2 other

Grade Mode: Satisfactory/Unsatisfactory-IP

MATH 70051 PROBABILITY I 4 Credit Hours

(Slashed with MATH 60051) Distribution functions, measure theory, random variables, expectation, independence, convergence, concepts, law of large numbers.

Prerequisite: MATH 40011 or MATH 50011; or MATH 42002 or MATH 52002; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 70052 PROBABILITY II 3 Credit Hours

(Slashed with MATH 60052) Characteristic functions, the central limit problem, conditional expectations, Martingale theory, Brownian motion.

Prerequisite: MATH 60051 or MATH 70051; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 70061 MATHEMATICAL STATISTICS I 4 Credit Hours

(Slashed with MATH 60061) Statistics, distributions of statistics. Sampling distributions. Decision spaces and loss functions. Sufficiency and completeness. Estimation theory. Rao Blackwell and the Cramer Rao theorems.

Prerequisite: MATH 42002 or MATH 52002.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 70062 MATHEMATICAL STATISTICS II 3 Credit Hours

(Slashed with MATH 60062) Tests of statistical hypothesis. Neyman Pearson Lemma. Exponential families and invariance. Sequential tests. Non parametric procedures.

Prerequisite: MATH 60061 or MATH 70061; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 70070 FINANCIAL MATHEMATICS 3 Credit Hours

(Slashed with MATH 70070) Topics from replication of trading strategies, arbitrage completeness, Martingale representation theorem, fundamental theorem of finance, stochastic differential equations, Black and Scholes formula of option pricing.

Prerequisite: MATH 50051 and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 70091 SEMINAR IN STATISTICS AND PROBABILITY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in statistics and probability.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 3 other

Grade Mode: Standard Letter-S/U

MATH 70094 COLLEGE TEACHING OF MATHEMATICS 1 Credit Hour

(Repeatable for credit) Techniques and problems in the teaching of college-level mathematics. Student presentations of mathematical papers and colloquia will be included.

Prerequisite: Doctoral standing.

Schedule Type: Lecture

Contact Hours: 1 lecture

Grade Mode: Standard Letter

MATH 70095 SELECTED TOPICS IN STATISTICS AND PROBABILITY 1-3 Credit Hours

(Repeatable for credit) Topics vary with each offering and complement topics covered in MATH 70051, MATH 70052, MATH 70061 and MATH 70062.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 71001 STRUCTURE OF RINGS AND ALGEBRAS I 3 Credit Hours

Advanced topics in ring theory, including Artinian rings, Noetherian rings, advanced commutative ring theory.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 71002 STRUCTURE OF RINGS AND ALGEBRAS II 3 Credit Hours

Advanced topics in ring theory including an introduction to homological algebra. Includes Dedekind domains, regular rings, torsion theory.

Prerequisite: MATH 71001 and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 71011 ADVANCED GROUP THEORY 3 Credit Hours

Advanced topics in group theory. Topics include permutation arguments, coprime actions, transfer theorems, nonsimplicity criteria. Properties of families of groups: solvable, p solvable, nilpotent, p groups.

Prerequisite: MATH 61051 or MATH 71051; and MATH 61052 or MATH 71052; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 71012 CHARACTERS OF FINITE GROUPS 3 Credit Hours

Development of characters of finite groups, their properties, orthogonality relations, integrality conditions. Applications include Burnside's paqb theorem and existence of Frobenius kernels in Frobenius groups.

Prerequisite: MATH 61051 or MATH 71051; and MATH 61052 or MATH 71052; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 71051 ABSTRACT ALGEBRA I 4 Credit Hours

(Slashed with MATH 61051) Advanced topics in group theory, including Sylow theorems, finite Abelian groups, divisible groups and related concepts. Includes one-hour problem session each week.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 71052 ABSTRACT ALGEBRA II 3 Credit Hours

(Slashed with MATH 61052) Advanced topics, commutative ring theory and field theory, including polynomial rings, unique factorization, domains, matrix rings, Galois theory.

Prerequisite: MATH 61051 or MATH 71051; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 71091 SEMINAR IN ALGEBRA 1-3 Credit Hours

(Repeatable for credit)(Slashed with MATH 61091) Seminar on current research in algebra.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 71095 SELECTED TOPICS IN ALGEBRA 1-3 Credit Hours

(Repeatable for credit) Topics vary with each offering and complement topics covered in MATH 71002, MATH 71051 and MATH 71052.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 72001 FUNCTIONAL ANALYSIS I 3 Credit Hours

A study of principles of linear analysis in the setting of normed linear spaces and topological vector spaces.

Prerequisite: MATH 72052 and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72002 FUNCTIONAL ANALYSIS II 3 Credit Hours

A study of principles of linear analysis in the setting of normed linear spaces and topological vector spaces.

Prerequisite: MATH 72001 and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72041 METHODS OF APPLIED MATHEMATICS I 3 Credit Hours

(Slashed with MATH 62041) Analysis and applications of ordinary and partial differential equations and related topics. Dimensional analysis (Buckingham Pi Theorem). Perturbation methods (singular perturbations, matched asymptotic expansions, WKB approximation). Variational methods (Euler-Lagrange equations).

Prerequisite: MATH 51021 and MATH 52041 and MATH 52045 and MATH 52048 and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72042 METHODS OF APPLIED MATHEMATICS II 3 Credit Hours

(Slashed with MATH 62042) Continuation of MATH 72041. Integral equations and Green's functions (Fredholm alternative, compact operators, distributions, weak solutions). Wave phenomena (dispersion, KdV equation). Stability and bifurcation (linearized stability analysis, turning points, Hopf bifurcation).

Prerequisite: MATH 62041 or MATH 72041; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72051 FUNCTIONS OF A REAL VARIABLE I 4 Credit Hours

(Slashed with MATH 62051) Introduction to modern concepts of real analysis including metric spaces, measure and integration theory.

Prerequisite: MATH 42002 or MATH 52002; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 72052 FUNCTIONS OF A REAL VARIABLE II 3 Credit Hours

(Slashed with MATH 62052). A continuation of MATH 72051. Included are basic topics in functional analysis and Hilbert space theory.

Prerequisite: MATH 62051 or MATH 72051; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72091 SEMINAR IN REAL ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in real analysis.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 72095 SELECTED TOPICS IN REAL ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Topics vary with each offering and complement topics covered in MATH 72002, MATH 72051 and MATH 72052.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 72151 FUNCTIONS OF A COMPLEX VARIABLE I 4 Credit Hours

(Slashed with MATH 62151) Topological properties of the complex plane; analytic, entire, meromorphic functions; analytic continuation; conformal mappings; Picard's Theorem; Riemann surfaces.

Prerequisite: MATH 52002; and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 72152 FUNCTIONS OF A COMPLEX VARIABLE II 3 Credit Hours

(Slashed with MATH 62152) Topological properties of the complex plane; analytic, entire, meromorphic functions; analytic continuation; conformal mappings; Picard's theorem; Riemann surfaces.

Prerequisite: MATH 72151; and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72191 SEMINAR IN COMPLEX ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in complex analysis.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 72195 SELECTED TOPICS IN COMPLEX ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Topics vary with each offering and complement topics covered in MATH 72151 and MATH 72152.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 72203 COMPUTATIONAL FINANCE 3 Credit Hours

(Slashed with MATH 62203) Basic numerical methods, (numerical linear algebra, nonlinear equations, curve fitting, ODEs, integration, Monte-Carlo methods) numerical solution of PDEs (stability, convergence, Black-Scholes, American options, SDEs) probabilistic methods.

Prerequisite: MATH 22005 and MATH 21001 and MATH 32044 and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72251 NUMERICAL ANALYSIS I 4 Credit Hours

(Slashed with MATH 62251) Floating point computation, rounding error analysis, conditioning, interpolation (polynomial, trigonometric spline). Numerical quadrature (Newton-Cotes, Gauss), extrapolation, Romberg integration.

Prerequisite: MATH 42002 or MATH 52002; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 72252 NUMERICAL ANALYSIS II 3 Credit Hours

(Slashed with MATH 62252) Numerical solution of linear systems of equations (LU factorization, error analysis). Least squares, orthogonalization methods. Algebraic eigenvalue problems, QR algorithm, singular value decomposition.

Prerequisite: MATH 41021 or MATH 51021; and MATH 62251 or MATH 72251; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72261 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 3 Credit Hours

(Slashed with MATH 62261) Discretization methods for ordinary differential equations and systems. Initial value and boundary value problems. Numerical implementation software and analysis.

Prerequisite: MATH 32044; and MATH 42202 or MATH 52202; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72262 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 3 Credit Hours

(Slashed with MATH 62262) Derivation and analysis of discrete methods (finite differences, finite elements) for the numerical solution of elliptic, hyperbolic and parabolic partial differential equations.

Prerequisite: MATH 42045 or MATH 52045; and MATH 42202 or MATH 52202; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72263 NUMERICAL SOLUTION OF LARGE SPARSE LINEAR SYSTEMS 3 Credit Hours

(Slashed with MATH 62263) (Cross-listed with CS 62263 and CS 72263) Construction and analysis of iterative methods for large systems of linear algebraic equations. Jacobi, Gauss-Seidel, SOR. Polynomial acceleration methods, conjugate gradients. Multi-grid methods.

Prerequisite: MATH 41021 or MATH 51021; and MATH 42202 or MATH 52202; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72264 NUMERICAL SOLUTION OF NONLINEAR SYSTEMS 3 Credit Hours

(Slashed with MATH 62264) (Cross-listed with CS 62264 and CS 72264) Construction and analysis of numerical methods for systems of nonlinear algebraic equations and optimization problems. Numerical implementation and software.

Prerequisite: MATH 42041 or MATH 52041; and MATH 42202 or MATH 52202; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 72291 SEMINAR IN NUMERICAL ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in numerical analysis.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 72295 SELECTED TOPICS IN NUMERICAL ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Topics vary with each offering and complement topics covered in MATH 72251 and MATH 72252.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 72391 SEMINAR IN MEASURE THEORY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in measure theory.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 72491 SEMINAR IN NONLINEAR ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in nonlinear analysis.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 72591 SEMINAR IN OPERATOR THEORY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in operator theory.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 72691 SEMINAR IN HARMONIC ANALYSIS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in harmonic analysis.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 73291 SEMINAR IN APPLIED MATHEMATICS 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in applied mathematics.

Prerequisite: Special approval and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 76051 INTRODUCTION TO TOPOLOGY I 4 Credit Hours

(Slashed with MATH 66051) Set theory, topological spaces, continuity, product spaces, quotient spaces separation axioms, compactness and metrizable.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Lecture

Contact Hours: 4 lecture

Grade Mode: Standard Letter

MATH 76052 INTRODUCTION TO TOPOLOGY II 3 Credit Hours

Geometric topology, including connectedness, continua, homotopy, the plane and 2 manifolds.

Prerequisite: MATH 66051 or MATH 76051 and Doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 76091 SEMINAR IN TOPOLOGY 1-3 Credit Hours

(Repeatable for credit) Seminar on current research in topology.

Prerequisite: Permission and Doctoral standing.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 76095 SELECTED TOPICS IN TOPOLOGY 1-3 Credit Hours

(Repeatable for credit) Topics vary with each offering and complement topics covered in MATH 76051 and MATH 76052.

Prerequisite: Special approval and doctoral standing.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 77011 ALGEBRAIC NUMBER THEORY 3 Credit Hours

Number fields and Dedekind domains; conjugates, norm and trace, discriminant, integral bases; arithmetic or quadratic and cyclotomic number fields; theory of ideals and class group; Dirichlet's theorem on units.

Prerequisite: MATH 57011; and MATH 61052 or MATH 71052; and doctoral standing.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 77012 ANALYTIC NUMBER THEORY 3 Credit Hours

Multiplicative functions and summatory functions, Riemann's Zeta function and the prime number theorem, L-functions and Dirichlet's theorem on primes in arithmetic progressions, asymptotic formula for partitions.

Prerequisite: MATH 57011 and MATH 62151 or MATH 72151.

Schedule Type: Lecture

Contact Hours: 3 lecture

Grade Mode: Standard Letter

MATH 77091 SEMINAR IN NUMBER THEORY 1-3 Credit Hours

(Repeatable for credit) (Slashed with MATH 67091) Seminar on current research in number theory.

Prerequisite: Doctoral standing and special approval.

Schedule Type: Seminar

Contact Hours: 1-3 other

Grade Mode: Standard Letter-S/U

MATH 77095 SELECTED TOPICS IN MATHEMATICS 1-3 Credit Hours

(Repeatable for credit) Course topic varies with each offering.

Prerequisite: Special approval.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 77098 RESEARCH 1-15 Credit Hours

(Repeatable for credit) Research or individual investigation. Credits are applied toward degree requirements with approval if letter grade of "S" is given.

Prerequisite: Doctoral standing.

Schedule Type: Research

Contact Hours: 1-15 other

Grade Mode: Standard Letter-S/U

MATH 77195 SELECTED TOPICS IN NUMBER THEORY 1-3 Credit Hours

(Repeatable for credit) Content varies with each offering and complements topics covered in MATH 77011 and MATH 77012.

Prerequisite: Doctoral standing and special approval.

Schedule Type: Lecture

Contact Hours: 1-3 lecture

Grade Mode: Standard Letter

MATH 87098 RESEARCH 1-15 Credit Hours

(Repeatable for credit) Research or individual investigation for doctoral students who have not yet passed their candidacy examinations. Credits earned may be applied toward degree if department approves.

Prerequisite: Doctoral standing.

Schedule Type: Research

Contact Hours: 1-15 other

Grade Mode: Standard Letter

MATH 87199 DISSERTATION I 15 Credit Hours

(Repeatable for credit) Doctoral dissertation, for which registration in at least two semesters is required first of which will be semester in which dissertation work is begun and continuing until the completion of 30 hours.

Prerequisite: Admission to Doctoral candidacy and Doctoral standing.

Schedule Type: Dissertation

Contact Hours: 15 other

Grade Mode: Satisfactory/Unsatisfactory-IP

MATH 87299 DISSERTATION II 15 Credit Hours

(Repeatable for credit) Continuing registration required of doctoral students who have completed the initial 30 hours of dissertation and continuing until all degree requirements are met.

Prerequisite: MATH 87199 and Doctoral standing.

Schedule Type: Dissertation

Contact Hours: 15 other

Grade Mode: Satisfactory/Unsatisfactory-IP