DEPARTMENT OF MATHEMATICS

The Department of Mathematics offers curricula which lead to the following undergraduate degrees: Bachelor of Science in Applied Mathematical Sciences, Bachelor of Arts in Mathematics and Bachelor of Science in Mathematics. An Integrated Fast Track combined baccalaureate/graduate degree program is also offered.

The curriculum for the BS in Applied Mathematical Sciences includes courses in economics, industrial engineering, statistics, computer science and mathematics. A student completing this program is prepared to enter employment with analytical and quantitative tools relevant to modern technological industries and/or modern financial markets. On the other hand, with the appropriate electives chosen, the student is prepared to enter quantitatively oriented graduate programs. Advising for this degree option is done through the Undergraduate Program Office in the Department of Mathematics.

With carefully chosen electives in education, any one of the above three degree plans can lead to teacher certification. Students interested in teacher certification may find the BA degree plan the most suitable since this degree plan offers the greatest flexibility for the inclusion of teacher certification courses.

Faculty

Allen, Angela J, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 2005

Anshelevich, Michael V, Professor
Mathematics
PHD, University of California, Berkeley, 2000

Aurispa, Benjamin, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 2006

Austin, Amy L, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 1994

Baskin, Dean R, Assistant Professor
Mathematics
PHD, Stanford University, 2010

Battle, Guy A, Professor
Mathematics
PHD, Duke University, 1977

Baudier, Florent P, Visiting Assistant Professor
Mathematics
PHD, Universite De Besancon, 2010

Belmonte, Arthur P, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 1986

Berkolaiko, Gregory, Professor
Mathematics
PHD, University of Bristol, United Kingdom, 1997

Boas, Harold P, Professor
Mathematics
PHD, Massachusetts Institute of Technology, 1980

Bollinger, Kathryn L, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 1998

Bonito, Andrea, Professor
Mathematics
PHD, Ecole Polytechnique Federale de Lausanne, France, 2006

Borosh, Itshak, Senior Professor
Mathematics
PHD, Weizmann Institute of Science, 1966

Brannan, Michael P, Assistant Professor
Mathematics
PHD, Queen's University, Canada, 2012

Bridy, Andrew D, Instructional Associate Professor
Mathematics
PHD, University of Wisconsin - Madison, 2014

Cai, Yue, Visiting Assistant Professor
Mathematics
PHD, University of Kentucky, 2016

Carter, Tamara A, Instructional Assistant Professor
Mathematics
PHD, Texas A&M University, 2005

Chen, Goong, Professor
Mathematics
PHD, University of Wisconsin - Madison, 1977

Comech, Andrew, Associate Professor
Mathematics
PHD, Columbia University, 1997

Daripa, Prabir, Associate Professor
Mathematics
PHD, Brown University, 1985

Demlow, Alan R, Professor
Mathematics
PHD, Cornell University, 2002

Devore, Ronald A, Distinguished Professor
Mathematics
PHD, The Ohio State University, 1967

Douglas, Ronald G, Distinguished Professor
Mathematics
PHD, Louisiana State University, 1962

Dykema, Kenneth J, Professor
Mathematics
PHD, University of California, Berkeley, 1993

Efendiev, Yalchin R, Professor
Mathematics
PHD, California Institute of Technology, 1999
Epstein, Janice L, Instructional Associate Professor
Mathematics
PHD, Texas A&M University, 1992

Erdelyi, Tamas, Professor
Mathematics
PHD, University of Southern Carolina, 1989

Foucart, Simon, Associate Professor
Mathematics
PHD, University of Cambridge, 2005

Fry, Erin K, Lecturer
Mathematics
MS, University of Illinois at Urbana-Champaign, 1990

Fulling, Stephen A, Professor
Mathematics
PHD, Princeton University, 1972

Geller, Susan C, Professor
Mathematics
PHD, Cornell University, 1975

Grigorchuk, Rostislav, Distinguished Professor
Mathematics
PHD, Lomonosov Moscow State University, 1986

Guermont, Jean-Luc, Professor
Mathematics
PHD, Sorbonne Universites, 1995

Gustafson, Robert A, Associate Professor
Mathematics
PHD, Yale University, 1979

Hanin, Boris, Assistant Professor
Mathematics
PHD, Northwestern University, 2014

Harris, Isaac, Visiting Assistant Professor
Mathematics
PHD, University of Delaware, 2015

Hester, Yvette C, Instructional Assistant Professor
Mathematics
PHD, Texas A&M University, 2000

Howard, Peter B, Professor
Mathematics
PHD, Indiana University, 1998

Johnson, William B, Distinguished Professor
Mathematics
PHD, Iowa State University, 1969

Jung, Junehyuk, Assistant Professor
Mathematics
PHD, Princeton University, 2013

Kahlig, Joseph E, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 1994

Kerr, David G, Professor
Mathematics
PHD, University of Toronto, 2001

Kilmer, Kendra R, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 2003

Kim, Jong Doo, Instructional Assistant Professor
Mathematics
PHD, State University of New York at Stony Brook, 2012

Klein, Gregory S, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 1992

Kuchment, Peter, Distinguished Professor
Mathematics
PHD, Kharkov State University, Russia, 1973

Lahodny, Glenn E, Instructional Assistant Professor
Mathematics
PHD, Texas Tech University, 2012

Landsberg, Joseph M, Professor
Mathematics
PHD, Duke University, 1990

Larson, David R, Professor
Mathematics
PHD, University of California, Berkeley, 1976

Lazarov, Raycho D, Professor
Mathematics
PHD, University of Moscow, Russia, 1972

Lee, Sang Rae, Lecturer
Mathematics
PHD, University of Oklahoma, 2012

Lewis, Jennifer L, Senior Lecturer
Mathematics
PHD, The Ohio State University, 1980

Liao, Benben, Visiting Assistant Professor
Mathematics
PHD, Institut de Mathematiques de Jussieu, 2014

Limafilho, Paulo C, Professor
Mathematics
PHD, State University of New York at Stony Brook, 1989

Lynch, Benjamin R, Lecturer
Mathematics
PHD, University of Tennessee, 2010

Lynch, Richard G, Visiting Assistant Professor
Mathematics
PHD, University of Missouri - Columbia, 2016

Manuel, David J, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 1994
Masri, Mohamad R, Associate Professor
Mathematics
PHD, The University of Texas at Austin, 2005

Matusievich, Laura F, Professor
Mathematics
PHD, University of California, Berkeley, 2002

Mogilevsky, Mila, Instructional Associate Professor
Mathematics
PHD, Rostov State University USSR, 1976

Motakis, Pavlos, Visiting Assistant Professor
Mathematics
PHD, National Technical University of Athens, 2015

Narici, Francis J, Professor
Mathematics
PHD, Princeton University, 1972

Nekrashevych, Volodymyr, Professor
Mathematics
PHD, Taras Shevchenko National University, Russia, 1998

Onica, Constantin, Instructional Assistant Professor
Mathematics
PHD, Texas A&M University, 2005

Orchard, Patrick J, Lecturer
Mathematics
MS, Texas A&M University, 2015

Paouris, Grigorios, Professor
Mathematics
PHD, University of Crete, 2004

Papanikolas, Matthew A, Professor
Mathematics
PHD, Brown University, 1998

Pasciak, Joseph E, Professor
Mathematics
PHD, Cornell University, 1977

Pearlstein, Gregory J, Associate Professor
Mathematics
PHD, University of Massachusetts Amherst, 1999

Pearlstein, Rosanna, Lecturer
Mathematics
PHD, University of Massachusetts Amherst, 1998

Petrova, Guergana P, Professor
Mathematics
PHD, University of Southern Carolina, 1999

Pitts, Jon T, Professor
Mathematics
PHD, Princeton University, 1974

Plavnik, Julia Y, Visiting Assistant Professor
Mathematics
PHD, Universidad Nacional de Cordoba, Argentina, 2013

Poltoratski, Alexei G, Professor
Mathematics
PHD, California Institute of Technology, 1995

Popov, Bojan D, Professor
Mathematics
PHD, University of Southern Carolina, 1999

Procaccia, Eviatar B, Assistant Professor
Mathematics
PHD, Weizmann Institute of Science, 2013

Rahm, Robert, Visiting Assistant Professor
Mathematics
PHD, Washington University in St. Louis, 2017

Ramsey, Heather L, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 2004

Reihani, Kamran, Instructional Assistant Professor
Mathematics
PHD, Tarbiat Modares University, 2005

Rojas, Joseph M, Professor
Mathematics
PHD, University of California, Berkeley, 1995

Roque-Sol, Marco A, Lecturer
Mathematics
PHD, Texas A&M University, 2006

Rowell, Eric C, Professor
Mathematics
PHD, University of California, San Diego, 2003

Rundell, William, Professor
Mathematics
PHD, University of Glasgow, 1974

Schielack, Vincent, Associate Professor
Mathematics
PHD, The University of Texas at Austin, 1982

Schlumprecht, Thomas B, Professor
Mathematics
PHD, Ludwig Maximilians Universitat, Germany, 1988

Schrader, Todd W, Lecturer
Mathematics
MS, Texas A&M University, 2016

Sengupta, Sinjini, Senior Lecturer
Mathematics
PHD, Florida State University, 2006

Shatalov, Oksana, Instructional Associate Professor
Mathematics
PHD, Technion - Israel Institute of Technology, 2001

Shiu, Anne J, Assistant Professor
Mathematics
PHD, University of California, Berkeley, 2010
Sivakumar, Natarajan, Associate Professor
Mathematics
PHD, University of Alberta, 1990

Smith, Roger R, Professor
Mathematics
PHD, University of Oxford, 1976

Sottile, Frank J, Professor
Mathematics
PHD, University of Chicago, 1994

Stiller, Peter F, Professor
Mathematics
PHD, Princeton University, 1977

Straube, Emil J, Professor
Mathematics
PHD, Swiss Federal Institute of Technology Zurich, 1983

Sunik, Zoran, Professor
Mathematics
PHD, State University of New York at Binghamton, 2000

Taliaferro, Steven D, Associate Professor
Mathematics
PHD, Stanford University, 1976

Tang, Xiaoxian, Visiting Assistant Professor
Mathematics
PHD, Peking University, China, 2014

Titi, Edriss S, Professor
Mathematics
PHD, Indiana University, 1986

Tomas, Ignacio, Visiting Assistant Professor
Mathematics
PHD, University of Maryland, 2015

Tretkoff, Paula, Professor
Mathematics
PHD, University of Nottingham, 1985

Tucker-Drob, Robin D, Assistant Professor
Mathematics
PHD, California Institute of Technology, 2013

Ventura, Emanuele, Visiting Assistant Professor
Mathematics
PHD, Aalto University, 2017

Vorobets, Mariya, Associate Professor
Mathematics
PHD, Lviv National University, 2004

Vorobets, Yaroslav, Instructional Assistant Professor
Mathematics
PHD, Lomonosov Moscow State University, 1998

Ward, Joseph D, Professor
Mathematics
PHD, Indiana University, 1973

Whitfield, Jennifer G, Instructional Assistant Professor
Mathematics
MS, Texas A&M University, 2000

Witherspoon, Sarah J, Professor
Mathematics
PHD, University of Chicago, 1994

Xie, Zhizhang, Assistant Professor
Mathematics
PHD, The Ohio State University, 2011

Yan, Huafei, Professor
Mathematics
PHD, Massachusetts Institute of Technology, 1997

Yang, Tian, Assistant Professor
Mathematics
PHD, Rutgers, The State University of New Jersey, 2013

Yasskin, Philip B, Associate Professor
Mathematics
PHD, University of Maryland, 1979

Young, Matthew P, Professor
Mathematics
PHD, Rutgers, The State University of New Jersey, 2004

Yu, Guoliang, Professor
Mathematics
PHD, State University Of New York at Stony Brook, 1991

Yu, Shilin, Visiting Assistant Professor
Mathematics
PHD, The Pennsylvania State University, 2013

Zelenko, Igor, Associate Professor
Mathematics
PHD, Technion - Israel Institute of Technology, 2002

Zhang, Yuan, Visiting Assistant Professor
Mathematics
PHD, Duke University, 2015

Zhang, Zheng, Visiting Assistant Professor
Mathematics
PHD, Stony Brook University, 2014

Zhou, Jianxin, Professor
Mathematics
PHD, The Pennsylvania State University, 1986

**Majors**

- Bachelor of Arts in Mathematics (http://catalog.tamu.edu/undergraduate/science/mathematics/ba)
- Bachelor of Arts in Mathematics and Master of Science in Mathematics, 5-Year Degree Program (http://catalog.tamu.edu/undergraduate/science/mathematics/ba-ms)
- Bachelor of Science in Mathematics (http://catalog.tamu.edu/undergraduate/science/mathematics/bs)
- Bachelor of Science in Mathematics and Master of Science in Mathematics, 5-Year Degree Program (http://catalog.tamu.edu/undergraduate/science/mathematics/bs-ms)
Minors

- Mathematics Minor (http://catalog.tamu.edu/undergraduate/science/mathematics/minor)

Courses

MATH 102 Algebra
Credits 3. 3 Lecture Hours.
(MATH 1314, 1414) Algebra. Sets, structure of number system; absolute values, solution sets of linear and nonlinear equations, of systems of equations, and of inequalities; relations and functions, graphical representations, graphical representations, progressions, mathematical induction, determinants.

MATH 131 Mathematical Concepts—Calculus
Credits 3. 3 Lecture Hours.
Mathematical Concepts—Calculus. Limits and continuity; rates of change, slope; differentiation: the derivative, maxima and minima; integration: the definite and indefinite integral techniques; curve fitting. No credit will be given for more than one of MATH 131, MATH 142, MATH 147, MATH 151 and MATH 171.
Prerequisites: High school algebra I and II and geometry.

MATH 140 Mathematics for Business and Social Sciences
Credits 3. 3 Lecture Hours.
(MATH 1324) Mathematics for Business and Social Sciences. (3.0). Application of common algebraic functions, including polynomial, exponential, logarithmic and rational, to problems in business, economics and the social sciences; includes mathematics of finance, including simple and compound interest and annuities; systems of linear equations; matrices; linear programming; and probability, including expected value. No credit will be given for more than one of MATH 140, MATH 141 and MATH 166.
Prerequisite: High school algebra I and II and geometry.

MATH 141 Finite Mathematics
Credits 3. 3 Lecture Hours.
Linear equations and applications; systems of linear equations, matrix algebra and applications, linear programming, probability and applications, statistics. No credit will be given for more than one of MATH 140, MATH 141 and MATH 166.
Prerequisites: High school algebra I and II and geometry.

MATH 142 Business Calculus
Credits 3. 3 Lecture Hours.
(MATH 1325, MATH 1425) Business Calculus. Derivatives, curve sketching and optimization, techniques of derivatives, logarithms and exponential functions with applications, integrals, techniques and applications of integrals, multivariate calculus. No credit will be given for more than one of MATH 131, MATH 142, MATH 147, MATH 151 and MATH 171.
Prerequisites: MATH 140 or equivalent or acceptable score on Texas A&M University math placement exam.

MATH 147 Calculus I for Biological Sciences
Credits 4. 3 Lecture Hours. 2 Lab Hours.
Introduction to differential calculus in a context that emphasizes applications in the biological sciences. No credit will be given for more than one of MATH 131, MATH 142, MATH 147, MATH 151 and MATH 171.
Prerequisite: MATH 150 or equivalent or acceptable score on TAMU Math Placement Exam.

MATH 148 Calculus II for Biological Sciences
Credits 4. 3 Lecture Hours. 2 Lab Hours.
Introduction to integral calculus in a context that emphasizes applications in the biological sciences; ordinary differential equations and analytical geometry. No credit will be given for more than one of MATH 148, MATH 152 and MATH 172.
Prerequisite: MATH 147 or approval of instructor.

MATH 150 Functions, Trigonometry and Linear Systems
Credits 4. 3 Lecture Hours. 2 Lab Hours.
(MATH 2412) Functions, Trigonometry and Linear Systems. Graphs, functions, college algebra and trigonometry, linear systems and vectors.

MATH 151 Engineering Mathematics I
Credits 4. 3 Lecture Hours. 2 Lab Hours.
(MATH 2413) Engineering Mathematics I. Rectangular coordinates, vectors, analytic geometry, functions, limits, derivatives of functions, applications, integration, computer algebra. MATH 171 designed to be a more demanding version of this course. No credit will be given for more than one of MATH 131, MATH 142, MATH 147, MATH 151 and MATH 171.
Prerequisite: MATH 150 or equivalent or acceptable score on TAMU Math Placement Exam.

MATH 152 Engineering Mathematics II
Credits 4. 3 Lecture Hours. 2 Lab Hours.
(MATH 2414) Engineering Mathematics II. Differentiation and integration techniques and their applications (area, volumes, work), improper integrals, approximate integration, analytic geometry, vectors, infinite series, power series, Taylor series, computer algebra. MATH 172 designed to be a more demanding version of this course. No credit will be given for more than one of MATH 148, MATH 152 and MATH 172.
Prerequisite: MATH 151 or equivalent.
MATH 161 Engineering Mathematics II
Credits 3. 3 Lecture Hours.
Differentiation and integration techniques and their applications (area, volumes, work), improper integrals, approximate integration, analytic geometry, vectors, infinite series, power series, Taylor series.
Prerequisite: MATH 151 or equivalent. Credit will not be given for more than one of MATH 152, 161 and 172.

MATH 166 Topics in Contemporary Mathematics II
Credits 3. 3 Lecture Hours.
Finite mathematics, matrices, probability and applications. No credit will be given for more than one of MATH 140, MATH 141 and MATH 166.
Prerequisites: High school algebra I and II and geometry.

MATH 167 Explorations in Mathematics
Credits 3. 3 Lecture Hours.
Application of mathematics to topics of contemporary societal importance using quantitative methods; may include elements of management science (optimal routes, planning and scheduling), statistics (sampling/polling methods, analyzing data to make decisions), cryptography (codes used by stores, credit cards, internet security), fairness (apportionment, voting) patterns (symmetry, tessellations, fractals), world health.
Prerequisites: High school algebra I and II.

MATH 170 Freshman Mathematics Laboratory
Credit 1. 2 Lab Hours.
Computing and problem solving laboratory; introduction to the various mathematical disciplines; development of skills in mathematical problem solving and skills in teamwork. May be taken two times for credit.
Prerequisites: Concurrent enrollment in MATH 171 or MATH 172; admission to College of Science.

MATH 171 Analytic Geometry and Calculus
Credits 4. 4 Lecture Hours.
Vectors, functions, limits, derivatives, Mean Value Theorem, applications of derivatives, integrals, Fundamental Theorem of Calculus. Designed to be more demanding than MATH 151. No credit will be given for more than one of MATH 131, MATH 142, MATH 147, MATH 151 and MATH 171.
Prerequisite: MATH 150 or equivalent or acceptable score on TAMU Math Placement Exam.

MATH 172 Calculus
Credits 4. 4 Lecture Hours.
Techniques of integration, applications of integrals, improper integrals, sequences, infinite series, vector algebra and solid analytic geometry. Designed to be more demanding than MATH 152. No credit will be given for more than one of MATH 148, MATH 152 and MATH 172.
Prerequisite: MATH 147, MATH 151 or MATH 171 or equivalent with a grade of C or better.

MATH 200 Horizons of Mathematics
Credit 1. 1 Lecture Hour.
Overview of different areas and topics of mathematics including logic, infinite sets, elements of topology, elements of history of mathematics; introduction to future courses in math degree plans and to some areas of research done by mathematics department faculty; topics may vary at the discretion of the instructor.
Prerequisites: MATH and APMS majors; freshmen or sophomore classification; approval of instructor.

MATH 220 Foundations of Mathematics
Credits 3. 3 Lecture Hours.
Foundations of mathematics including logic, set theory, combinatorics, and number theory.
Prerequisite: MATH 148, MATH 152 or MATH 172 or equivalent with a grade of C or better.

MATH 221 Several Variable Calculus
Credits 4. 4 Lecture Hours.
Vector algebra and solid analytic geometry; calculus of functions of several variables; Lagrange multipliers; multiple integration, theory, methods and application; line and surface integrals, Green's and Stokes' theorems; Jacobians. Designed to be more demanding than MATH 251 and MATH 253. No credit will be given for more than one of MATH 221, MATH 251 and MATH 253.
Prerequisite: MATH 148, MATH 152, or MATH 172.

MATH 225 Advanced Spreadsheet Techniques
Credit 1. 1 Lecture Hour.
Advanced commands, formatting and functionality of spreadsheets, with Excel being the particular example.
Prerequisite: MATH or APMS major.

MATH 251 Engineering Mathematics III
Credits 3. 3 Lecture Hours.
Vector algebra, calculus of functions of several variables, partial derivatives, directional derivatives, gradient, multiple integration, line and surface integrals, Green's and Stokes' theorems. MATH 221 designed to be a more demanding version of this course. No credit will be given for more than one of MATH 221, MATH 251 and MATH 253.
Prerequisite: MATH 148, MATH 152, or MATH 172.

MATH 253 Engineering Mathematics III
Credits 4. 3 Lecture Hours. 2 Lab Hours.
(MATH 2415) Engineering Mathematics III. Vector algebra; calculus of functions of several variables, partial derivatives, directional derivatives, gradient, multiple integration, line and surface integrals, Green's and Stokes' theorems, computer algebra. MATH 221 designed to be a more demanding version of this course. No credit will be given for more than one of MATH 221, MATH 251 and MATH 253.
Prerequisite: MATH 148, MATH 152, or MATH 172.

MATH 281 Seminar in Mathematics
Credit 1. 1 Lecture Hour.
Designed to familiarize students with mathematics pertaining to real world applications in such areas as biology, signal processing, quantum computation and robotics. May be taken four times for credit.

MATH 285 Directed Studies
Credits 1 to 4. 1 to 4 Other Hours.
Special problems not covered by any other lower-division course in the curriculum; intended for freshman and sophomore students.
Prerequisite: Approval of department head.

MATH 289 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours.
Selected topics in an identified area of mathematics. May be repeated for credit.
Prerequisite: Approval of instructor.

MATH 291 Research
Credits 0 to 4. 0 to 4 Other Hours.
Research conducted under the direction of faculty member in mathematics. May be repeated 2 times for credit.
Prerequisites: Freshman or sophomore classification and approval of instructor.
MATH 302 Discrete Mathematics
Credits 3. 3 Lecture Hours.
Formal structures for describing data, algorithms and computing devices; theory and applications of sets, graphs and algebraic structures.
Prerequisite: MATH 148, MATH 152, or MATH 172.

MATH 304 Linear Algebra
Credits 3. 3 Lecture Hours.
Introductory course in linear algebra covering abstract ideas of vector space and linear transformation as well as models and applications of these concepts, such as systems of linear equations, matrices and determinants. MATH 323 designed to be a more demanding version of this course. No credit will be given for more than one of MATH 304, MATH 309, MATH 311 and MATH 323.
Prerequisite: MATH 148, MATH 152, or MATH 172; junior or senior classification.

MATH 308 Differential Equations
Credits 3. 3 Lecture Hours.
Prerequisites: MATH 221, MATH 251, or MATH 253, or concurrent enrollment; knowledge of computer algebra system.

MATH 309 Linear Algebra for Differential Equations
Credits 3. 3 Lecture Hours.
Systems of linear equations, matrices, determinants, vector spaces, linear transformations, eigenvalues and eigenvectors, diagonalization, inner product spaces, orthogonal functions, separation of variables, Fourier series, Bessel functions. No credit will be given for more than one of MATH 304, MATH 309, MATH 311 and MATH 323.
Prerequisites: MATH 221, MATH 251, or MATH 253; MATH 308 or concurrent enrollment; junior or senior classification or approval of instructor.

MATH 311 Topics in Applied Mathematics I
Credits 3. 3 Lecture Hours.
Systems of linear equations, matrices, determinants, vector spaces, linear transformations, eigenvalues and eigenvectors, diagonalization, inner product spaces, orthogonal functions; vector analysis, including gradient, divergence, curl, line and surface integrals, Gaus's, Green's and Stokes' theorems. No credit will be given for more than one of MATH 304, MATH 309, MATH 311 and MATH 323.
Prerequisites: MATH 221, MATH 251, or MATH 253; MATH 308 or concurrent enrollment; junior or senior classification or approval of instructor.

MATH 323 Linear Algebra
Credits 3. 3 Lecture Hours.
Linear equations and matrices; real vector spaces, linear transformations, change of bases, determinants, eigenvalues and eigenvectors, diagonalization, inner products. Designed to include more theory and be more demanding than MATH 304. No credit will be given for more than one of MATH 304, MATH 309, MATH 311 and MATH 323.
Prerequisites: MATH 148, MATH 152 or MATH 172; MATH 220; junior or senior classification or approval of instructor.

MATH 325 The Mathematics of Interest
Credits 3. 3 Lecture Hours.
The mathematical theory associated with interest; annuities; internal rate of return; coupon bonds; valuation of noncallable bonds; yield of maturity; interest rate sensitivity; duration and convexity; reinvestment risk; total return; compound return; STRIPS; yield curve; short selling; hedge ratio; bond swaps.
Prerequisites: MATH 142, MATH 147, MATH 151 or MATH 171.

MATH 350 Introduction to Abstract Mathematical Structures
Credits 3. 3 Lecture Hours.
Formal structures for describing data, algorithms and computing devices; theory and applications of sets, graphs and algebraic structures.
Prerequisite: MATH 148, MATH 152, or MATH 172.

MATH 367 Basic Concepts of Geometry
Credits 3. 3 Lecture Hours.
Formal development of geometry: finite [Euclidean and non-Euclidean]. Designed primarily for elementary mathematics teacher certification. Others must have consent of instructor.
Prerequisite: MATH 365 or equivalent with a grade of C or better.

MATH 368 Introduction to Abstract Mathematical Structures
Credits 3. 3 Lecture Hours.
Mathematical proofs, sets, relations, functions, infinite cardinal numbers, algebraic structures, structure of the real line; designed primarily for elementary teacher certification.
Prerequisite: MATH 366 or equivalent with a grade of C or better.

MATH 375 Intermediate Real Analysis
Credits 3. 3 Lecture Hours.
Development of the real numbers, limits, foundations and major theorems of calculus. Designed primarily for mathematics teacher certification. Others must have consent of instructor.
Prerequisite: MATH 220 or equivalent.

MATH 376 Intermediate Abstract Algebra
Credits 3. 3 Lecture Hours.
Relations, functions, binary operators, rings, homomorphisms, integral domains and fields. Designed primarily for mathematics teacher certification. Others must have consent of instructor.
Prerequisites: MATH 220 or MATH 302; MATH 304 or equivalent.

MATH 379 Communications in Mathematics
Credit 1. 1 Lecture Hour.
Electronic, written, and oral communications in mathematics.
Prerequisites: MATH 220, junior or senior classification, and mathematics major.

MATH 401 Advanced Engineering Mathematics
Credits 3. 3 Lecture Hours.
Engineering mathematics including Perturbation Theory, Fourier series and partial differential equations. Designed primarily for engineering majors. Others must have consent of instructor.
Prerequisite: MATH 308.

MATH 403 Mathematics and Technology
Credits 3. 3 Lecture Hours.
Mathematical problem-solving and communication through the use of various technologies (both hardware and software). Intended primarily, but not limited to, students working toward teacher certification.
Prerequisite: MATH 367 or MATH 467 with a grade of C or better.
MATH 407 Complex Variables
Credits 3. 3 Lecture Hours.
Fundamental theory of analytic functions, including residues and their applications.
Prerequisite: MATH 221, MATH 251, or MATH 253.

MATH 409 Advanced Calculus I
Credits 3. 3 Lecture Hours.
Axioms of the real number system; point set theory of R; compactness, completeness and connectedness; continuity and uniform continuity; sequences, series; theory of Riemann integration.
Prerequisites: MATH 220, MATH 221, MATH 251 or MATH 253.

MATH 410 Advanced Calculus II
Credits 3. 3 Lecture Hours.
Differential and integral calculus of functions defined on Rn including inverse and implicit function theorems and change of variable formulas for integration; uniform convergence.
Prerequisites: MATH 304 or MATH 323; MATH 409.

MATH 411 Mathematical Probability
Credits 3. 3 Lecture Hours.
Probability spaces, discrete and continuous random variables, special distributions, joint distributions, expectations, law of large numbers, the central limit theorem.
Prerequisite: MATH 148, MATH 152, or MATH 172.

MATH 412 Theory of Partial Differential Equations
Credits 3. 3 Lecture Hours.
Formulation and solution of partial differential equations of mathematical physics; Fourier series and transform methods, complex variable methods, methods of characteristics and first order equations.
Prerequisite: MATH 308 or approval of instructor.

MATH 414 Fourier Series and Wavelets
Credits 3. 3 Lecture Hours.
Fourier series and wavelets with applications to data compression and signal processing.
Prerequisite: MATH 304, MATH 309, MATH 311, or MATH 323.

MATH 415 Modern Algebra I
Credits 3. 3 Lecture Hours.
A study of groups, rings, fields with emphasis on the theoretical aspects and proofs.
Prerequisite: MATH 220, MATH 304 or MATH 323.

MATH 416 Modern Algebra II
Credits 3. 3 Lecture Hours.
Continuation of topics introduced in MATH 415 including Galois Theory and the Sylow Theorems with emphasis on the theoretical aspects.
Prerequisite: MATH 415, junior or senior classification.

MATH 417 Numerical Methods
Credits 4. 3 Lecture Hours. 3 Lab Hours.
Numerical methods for applications; qualitative discussion of convergence and stability properties; computer implementation; interpolation and quadrature, initial value problems, matrix decompositions, interactive solution of linear and non-linear systems, least squares approximation, boundary value problems for ordinary differential equations.
Prerequisites: MATH 304, MATH 309, MATH 311, or MATH 323; MATH 308; ability to program; junior or senior classification.

MATH 419 Applications of Actuarial Science
Credits 2. 2 Lecture Hours.
Applications of actuarial science using mathematical and statistical methods to assess risk in the insurance and finance industries; emphasis on probability, statistics, finance and economics; focus on using probabilistic models in the estimation of insurance premiums.
Prerequisite: MATH 411 or STAT 414 or approval of math advisor.

MATH 420 Application of Actuarial Science II
Credits 2. 2 Lecture Hours.
Use of mathematical and statistical methods to price various financial instruments, such as bonds; understanding how the term structure of interest rates affect the price of these instruments.
Prerequisite: MATH 325 or concurrent enrollment, or approval of instructor.

MATH 423 Linear Algebra II
Credits 3. 3 Lecture Hours.
Eigenvalues, similarity and canonical forms, advanced topics to be chosen by the instructor.
Prerequisites: MATH 220 or CSCE 222/ECEN 222; MATH 304 or MATH 323, or approval of instructor.

MATH 425 The Mathematics of Contingent Claims
Credits 3. 3 Lecture Hours.
The mathematical theory associated with asset price dynamics; binomial pricing models; Black-Scholes analysis; hedging; volatility smile; implied volatility trees; implied binomial trees.
Prerequisites: MATH 308; MATH 411, STAT 211 or STAT 414.

MATH 427 Introduction to Number Theory
Credits 3. 3 Lecture Hours.
Prime and composite integers; Euclidean algorithm; modular arithmetic; Chinese remainder theorem; unique factorization; quadratic reciprocity; Riemann zeta function; representation of numbers as a sum of squares.
Prerequisites: MATH 220; MATH 304 or MATH 323.

MATH 431 Structures and Methods of Combinatorics
Credits 3. 3 Lecture Hours.
Enumerative techniques generating functions, partially ordered sets, elementary graph theory, elementary Ramsey theory.
Prerequisite: MATH 220 or MATH 302 or approval of instructor.

MATH 433 Applied Algebra
Credits 3. 3 Lecture Hours.
An introduction to groups, rings, fields with emphasis on modular arithmetic; applications to number theory, coding theory, and other areas.
Prerequisites: MATH 220 or MATH 302; MATH 304 or MATH 323.

MATH 436 Introduction to Topology
Credits 3. 3 Lecture Hours.
Metric spaces; continuity of metric spaces; topological spaces; basic notions; separation axioms; compactness; local compactness; connectedness; basic notions in homotopy theory; quotient spaces, paracompactness and topological manifolds.
Prerequisites: MATH 220, MATH 221, MATH 251, or MATH 253.
MATH 437 Principles of Numerical Analysis  
Credits 4. 3 Lecture Hours. 3 Lab Hours.  
Mathematical principles of numerical analysis and their application to  
the study of particular methods; fixed-point iteration, Newton's method;  
normed vector spaces and operators, Schur decomposition, convergent  
matrices, minimization methods, conjugate gradient method; polynomial  
interpolation of Lagrange and Hermite; best approximation, Bernstein and  
Weierstrass Theorems, numerical quadrature.  
**Prerequisites:** MATH 304, MATH 309, MATH 311, or MATH 323;  
MATH 308; MATH 409; ability to program; junior or senior classification.  

MATH 439 Differential Geometry of Curves and Surfaces  
Credits 3. 3 Lecture Hours.  
Local and global theory of parameterized curves; regular surfaces,  
local coordinates, first fundamental form, orientation, area; Gauss map,  
second fundamental form; Gauss Bonnet theorem; additional topics to be  
selected by the instructor.  
**Prerequisites:** MATH 308; MATH 304 or MATH 323.  

MATH 442 Mathematical Modeling  
Credits 3. 3 Lecture Hours.  
The construction of mathematical models from areas such as  
economics, game theory, integer programming, mathematical biology and  
mathematical physics.  
**Prerequisites:** MATH 304, MATH 309, MATH 311, or MATH 323;  
MATH 308 or equivalent.  

MATH 446 Principles of Analysis I  
Credits 3. 3 Lecture Hours.  
Construction of the real and complex numbers; topology of metric  
spaces, compactness and connectedness; Cauchy sequences,  
completeness and the Baire Category Theorem; Continuous Mappings;  
introduction to Point-Set Topology.  
**Prerequisites:** MATH 409; junior or senior classification.  

MATH 447 Principles of Analysis II  
Credits 3. 3 Lecture Hours.  
Riemann-Stieltjes integration; sequences and series of functions; the  
Stone-Weierstrass and Arzela-Ascoli Theorems; introduction to Lebesgue  
measure theory and integration.  
**Prerequisites:** MATH 446 or approval of instructor; junior or senior  
classification.  

MATH 460 Tensors and General Relativity  
Credits 3. 3 Lecture Hours.  
Vectors and tensors in special relativity, curvature, manifolds, covariant  
derivatives, Einstein field equations, Schwarzschild geometry and  
black holes, cosmology, gauge field theories.  
**Prerequisites:** MATH 308; PHYS 331 or MATH 323 or MATH 311; junior or  
senior classification.  

MATH 467 Modern Geometry  
Credits 3. 3 Lecture Hours.  
Modern development of Euclidean geometry (Hilbert axioms) with  
historical and philosophical context; independence of the parallel  
postulate; models of hyperbolic non-Euclidean geometry.  
**Prerequisite:** MATH 304, MATH 309, MATH 311, MATH 323 or MATH 220.  

MATH 469 Introduction to Mathematical Biology  
Credits 3. 3 Lecture Hours.  
Introduction to mathematical modeling techniques in the biological  
sciences; continuous versus discrete models; deterministic versus  
stochastic models; includes population dynamics and ecology, spread  
of infectious diseases, population genetics and evolution, spatial pattern  
formation.  
**Prerequisites:** MATH 304 or MATH 323; MATH 308 or equivalent.  

MATH 470 Communications and Cryptography  
Credits 3. 3 Lecture Hours.  
Introduction to coded communications, digital signatures, secret sharing,  
one-way functions, authentication, error control and data compression.  
**Prerequisites:** MATH 304 or MATH 309 or MATH 311 or MATH 323;  
CSCE 110 or CSCE 111 or CSCE 121 or CSCE 206 or ENGR 112; approval  
of instructor.  

MATH 471 Communications and Cryptography II  
Credits 3. 3 Lecture Hours.  
Additional topics in coded communications; information and entropy,  
elliptical curves, error corrections, quantum methods.  
**Prerequisites:** MATH 470 or consent of instructor.  

MATH 482 Research Seminar  
Credits 3. 3 Lecture Hours.  
Problems, methods and recent developments in mathematics, with  
emphasis on projects, and written and oral presentations. May be  
repeated for credit.  
**Prerequisites:** MATH 409 or MATH 415 (may be taken concurrently);  
junior or senior classification; approval of instructor.  

MATH 485 Directed Studies  
Credits 1 to 8. 1 to 8 Other Hours.  
Special problems in mathematics not covered by any other course in the  
curriculum. Work may be in either theory or laboratory.  
**Prerequisite:** Approval of department head.  

MATH 489 Special Topics in...  
Credits 1 to 4. 1 to 4 Lecture Hours.  
Selected topics in an identified area of mathematics. May be repeated for  
credit.  
**Prerequisite:** Approval of instructor.  

MATH 490 The Putnam Challenge  
Credit 1. 1 Lecture Hour.  
Intensive individualized training for preparation for the Putnam Exam, a  
national contest for mathematics majors. May be taken four times for  
credit.  
**Prerequisites:** Approval of instructor; junior or senior classification.  

MATH 491 Research  
Credits 0 to 3. 0 to 3 Other Hours.  
Active research of basic nature under supervision of Department of  
Mathematics or affiliated department graduate faculty member; a  
maximum of 6 hours of credit can be used in degree plans. Registration  
in multiple sections of this course is possible within a given semester  
provided that the per semester credit hour limit is not exceeded.  
**Prerequisites:** Mathematics or applied mathematical sciences major;  
junior or senior classification or approval of mathematics advisor.