**Department of Mathematics**

**College of Natural Science**

**100E Intermediate Algebra Workshop for the Mathematics Enrichment Program**
Fall, Spring. 1(0-4) R: Approval of department.
C: MTH 1025 concurrently.
Enrichment topics in intermediate algebra for students in the Mathematics Enrichment Program.

**103 College Algebra**
Fall, Spring, Summer. 3(3-0) P: (MTH 1825) or designated score on Mathematics Placement test SA: LBS 117 Not open to students with credit in MTH 116.
Number systems; functions and relations; exponents and logarithms; elementary theory of equations; inequalities; and systems of equations.

**103E College Algebra Workshop for the Mathematics Enrichment Program**
Fall, Spring. 1(0-4) R: Approval of department.
C: MTH 103 concurrently.
Enrichment topics in college algebra for students in the Mathematics Enrichment Program.

**110 Finite Mathematics and Elements of College Algebra**
Fall, Spring, Summer. 5(5-0) P: (MTH 1825) or designated score on Mathematics Placement test Not open to students with credit in MTH 110.

**110E Finite Mathematics and Elements of College Algebra for Mathematics Enrichment**
Spring. 1(0-2) R: Approval of department.
C: MTH 110 concurrently.
Enrichment topics in finite mathematics and elements of college algebra.

**112 Finite Mathematics: Applications of College Algebra**
Fall, Spring, Summer. 3(3-0) P: (MTH 103) or designated score on Mathematics Placement test SA: MTH 106 Not open to students with credit in MTH 110.
Combinatorics, probability and statistics, mathematics of finance, geometry, transition matrices, and linear programming. The course emphasizes applications and includes work using spreadsheets.

**114 Trigonometry**
Fall, Spring, Summer. 3(3-0) P: MTH 103 SA: MTH 104 Not open to students with credit in MTH 116.
Radian and degree measure of angles. Definitions and graphs of trigonometric functions and their inverses. Solving trigonometric equations. Applications including identities, indirect measurement and trigonometric modeling.

**116 College Algebra and Trigonometry**
Fall, Spring, Summer. 5(5-0) P: (MTH 1825) or designated score on Mathematics Placement test SA: LBS 117 Not open to students with credit in MTH 103.

**116E Precalculus Workshop for the Emerging Scholars Program**
Fall. 1(0-4) R: Approval of department.
C: MTH 116 concurrently.
Enrichment topics in precalculus for students in the Emerging Scholars Program.

**124 Survey of Calculus I**
Fall, Spring, Summer. 3(3-0) P: (MTH 103 or MTH 116) or designated score on Mathematics Placement test Not open to students with credit in LB 118 or MTH 132 or MTH 152H.
Study of limits, continuous functions, derivatives, integrals and their applications.

**124E Survey of Calculus with Applications I Mathematics Enrichment Workshop**
Fall. 1(0-4) R: Approval of department.
C: MTH 124 concurrently.
Enrichment topics in Survey of Calculus with Applications I for students in the Mathematics Enrichment Program.

**126 Survey of Calculus II**
Fall, Spring, Summer. 3(3-0) P: MTH 124 Not open to students with credit in MTH 133 or MTH 153H.
Application of partial derivatives, integrals, optimization of functions of several variables and differential equations.

**132 Calculus I**
Fall, Spring, Summer. 3(3-0) P: (MTH 103 and MTH 114) or (MTH 116 or designated score on Mathematics Placement test ) Not open to students with credit in LB 118 or MTH 152H.
Limits, continuous functions, derivatives and their applications. Integrals and the fundamental theorem of calculus.

**132E Calculus I Workshop for the Emerging Scholars Program**
Fall, Spring. 2(0-6) R: Approval of department.
C: MTH 132 concurrently.
Enrichment topics in Calculus I for students in the Emerging Scholars Program.

**133 Calculus II**
Fall, Spring, Summer. 4(4-0) P: MTH 132 or MTH 152H or LB 119 Not open to students with credit in LB 119 or MTH 153H.

**133E Calculus II Workshop for the Emerging Scholars Program**
Fall, Spring. 1(0-4) R: Approval of department.
C: MTH 133 concurrently.
Enrichment topics in Calculus II for students in the Emerging Scholars Program.

**152H Honors Calculus I**
Fall. 3(3-0) R: Open to students in the Honors College or approval of department. Not open to students with credit in LB 119 or MTH 132.
Limits, continuous functions, derivatives, integrals, fundamental theorem of calculus. Special emphasis on concepts and theory.

**153H Honors Calculus II**
Fall, Spring. 4 credits. P: MTH 152H or MTH 132 or LB 118 R: Open to students in the Honors College or approval of department. Not open to students with credit in LB 119 or MTH 153H.

**1825 Intermediate Algebra**
Fall, Spring, Summer. 3(3-0) Properties of real numbers. Factoring. Roots and radicals. First and second degree equations. Linear inequalities. Polynomials. Systems of equations.

**201 Elementary Mathematics for Teachers I**
Fall, Spring, Summer. 3(3-0) P: (MTH 103 or MTH 110 or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LB 118) or designated score on Mathematics Placement test R: Open to students in the Child Development major or in the Education major or in the Special Education-Deaf Education major or in the Special Education-Learning Disabilities major or in the Teacher Certification Internship Year Studies Program.
Mathematics needed for K-8 teaching. Place value and models for arithmetic, mental math, word problems, and algorithms. Factors, primes, proofs, and prealgebra. Fractions, ratios, rates, and percent- ages. Negative, rational, and real numbers. Special emphasis on the appropriate sequential order for teaching.

**202 Elementary Mathematics for Teachers II**
Fall, Spring, Summer. 3(3-0) P: (MTH 103 or MTH 110 or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LB 118) R: Open to students in the Child Development major or in the Education major or in the Special Education-Deaf Education major or in the Special Education-Learning Disabilities major or in the Teacher Certification Internship Year Studies Program.
A continuation of MTH 201. Geometry, measurement, and elementary data analysis.

**234 Multivariable Calculus**
Fall, Spring, Summer. 4(4-0) P: MTH 133 or MTH 153H or LB 119 Not open to students with credit in MTH 254H or LB 220.
Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green’s and Stokes’s theorems.

**235 Differential Equations**
Fall, Spring, Summer. 3(3-0) P: MTH 234 or MTH 254H or LB 220 R: Not open to students in the Department of Mathematics or in the Lyman Briggs Computational Mathematics Coordinate Major or in the Lyman Briggs Mathematics Coordinate Major. Not open to students with credit in MTH 255H.

**254H Honors Multivariable Calculus**
Fall, Spring. 4 credits. P: MTH 153H or MTH 133 or LB 119 R: Open to students in the Honors College or approval of department. Not open to students with credit in LB 220 or MTH 234.
Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green’s and Stokes’s Theorems.
Mathematics—MTH

255H Honors Differential Equations
Fall, Spring. 3(3-0) P: MTH 254H R: Not open to students in the Bachelor of Arts in Mathematics or Bachelor of Science in Mathematics or Lyman Briggs School Mathematics coordinate majors. Not open to students with credit in MTH 235.
Topics chosen from separable and exact equations, linear equations and variation of parameters, series solutions, higher order linear equations, Laplace transforms, systems of first-order linear equations, nonlinear equations and stability, introduction to partial differential equations.

290 Directed Study
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
Faculty directed study of selected mathematical topics.

291 Mathematics Snapshots
Spring. 1(2-0) A student may earn a maximum of 2 credits in all enrollments for this course. P: MTH 116 or approval of department.
Selected topics in mathematics and its applications. Emphasis will be on important and intriguing ideas in mathematics without indulging in technical details.

299 Transitions
Fall, Spring, Summer. 4 credits. P: MTH 132 or LB 118 RB: (MTH 133 or concurrent-ly) or (LB 119 or concurrently)
Introduction to mathematical reasoning, basic logic, set theory, integers, natural numbers and induction, basic number theory, real numbers, limits, sequences, series.

301 Foundations of Higher Mathematics
Fall, Spring. 3(3-0) P: MTH 133 or MTH 153H or LB 119
Elementary set theory including permutations, combinations, cardinality theorems, relations, functions and quotient sets. Basic principles of logic and proof techniques. Elementary number theory and abstract algebra.

304 Algebra for Elementary and Middle School Teachers
Fall. 3 credits. Interdepartmental with Teacher Education. Administered by Mathematics. P: (MTH 201 and MTH 202 and MTH 301) and completion of Tier I writing requirement R: Open to undergraduate students in the College of Education or in the Department of Teacher Education. Approval of department.
Algebra needed for understanding connections between topics of algebra and the mathematics taught in elementary and middle school.

305 Functions and Calculus for Elementary and Middle School Teachers (W)
Spring. 3 credits. Interdepartmental with Teacher Education. Administered by Mathematics. P: MTH 304
Functions and calculus needed for understanding connections between topics of calculus and the mathematics taught in middle school.

309 Linear Algebra I
Fall, Spring, Summer. 3(3-0) P: (MTH 133 or MTH 153H or LB 119) and completion of Tier I writing requirement and (MTH 299 or approval of department)
Matrices, systems of linear equations, vector spaces, linear transformations, inner products and orthogonal spaces, eigenvalues and eigenvectors, and applications to geometry. A writing course with emphasis on proofs.

310 Abstract Algebra I and Number Theory
Fall, Spring, Summer. 3(3-0) P: (MTH 299 or MTH 317H) or approval of department) and completion of Tier I writing requirement Structure of the integers, congruences, rings, ring homomorphisms, ideals, quotient rings. A writing course with an emphasis on proofs.

314 Matrix Algebra with Applications
Fall, Spring, Summer. 3(3-0) P: MTH 234 or MTH 254H or LB 220 R: Not open to students in the Department of Mathematics or the Lyman Briggs Computational Mathematics Coordinate Major or the Lyman Briggs Mathematics Coordinate Major.
Problem-solving and applications in matrix algebra for scientists and engineers. Vectors, matrices, linear transformations, inner products, dimension, eigenvalues and eigenvectors. Applications to systems of equations and to geometry.

317H Honors Linear Algebra
Fall, Spring, Summer. 4 credits. P: MTH 133 or MTH 153H or LB 119 R: Open to students in the Honors College or approval of department.
Systems of equations, matrix algebra, vector spaces, linear transformations, geometry of R^n, eigenvalues and eigenvectors. Applications to mathematical reasoning, proofs, and concepts.

320 Analysis I
Fall, Spring, Summer. 3(3-0) P: (MTH 133 or MTH 153H or LB 119) and (MTH 299 or MTH 317H or approval of department) Not open to students with credit in MTH 327H.

327H Honors Introduction to Analysis
Fall, Spring. 3(3-0) P: MTH 317H R: Approval of department. Not open to students with credit in MTH 320.
Emphasis on foundations and metric topology. Convergence of sequence and series, continuity of functions, differentiation and integration in one dimension.

330 Higher Geometry
Fall, Spring, Summer. 3(3-0) P: MTH 301 or MTH 309 or MTH 299 or MTH 317H
Topics in transformations: isometries, similarities, inversion, Advanced Euclidean geometry; Theorem of Menelaus, Ceva, and Desargues. Cross ratio, harmonic points, analytic, metric, and vector methods, and convexity.

340 Ordinary Differential Equations I
Fall, Spring, Summer. 3(3-0) P: MTH 309 Techniques for solving differential equations, existence and uniqueness theorems, qualitative theory, Fourier series and applications.

347H Advanced Ordinary Differential Equations
Spring. 3(3-0) P: MTH 317H R: Approval of department.
Separable and exact equations, linear equations and variation of parameters, higher order linear equations, Laplace Transforms, first-order linear systems, classification of singularities, nonlinear systems, partial differential equations and Fourier Series, existence and uniqueness theorems. There will be an emphasis on theory.

360 Theory of Mathematical Interest
Fall, Spring. 3(3-0) P: (MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently) or approval of department
Measurement of interest rates, basic problems in interest theory, basic annuities, continuous and varying annuities, yield rates, amortization, bonds and other securities, practical applications, and stochastic approaches to interest.

370 Mathematical Biology
Fall. 3(3-0) P: (MTH 133 or LB 119) and (BS 161 or BS 162 or BS 181H or BS 182H or LB 144 or LB 145)

371 Statistical Biology
Spring. 3(3-0) P: (BS 161 or BS 162) and (BS 181H or BS 182H or LB 144 or LB 145)
Probability models in biological systems. Design and analysis of biological experiments including ANOVA models. Multiple testing. Classification and clustering for genomic and proteomic data. Computational software packages. Internet-based query systems.

396 Capstone in Mathematics for Secondary Education (W)
Spring. 3(3-0) P: (((MTH 309 and MTH 310 and MTH 320) or approval of department) and completion of Tier I writing requirement R: Approval of department. Not open to students with credit in MTH 496.
A capstone course for secondary education math majors. High school mathematics from an advanced viewpoint.

411 Abstract Algebra II
Fall, Spring. 3(3-0) P: MTH 310 Not open to students with credit in MTH 418H.
Continuation of MTH 310. Permutation groups, groups of transformations, normal subgroups, homomorphism theorems, modules. Principal ideal rings, unique factorization domains, noncommutative rings, rings of fractions, ideals.

414 Linear Algebra II
Fall. 3(3-0) P: MTH 309 or MTH 314 Not open to students with credit in MTH 415.
Linear transformations on finite dimensional vector spaces. Invariant subspaces, rank, eigenvalues and eigenvectors. Canonical forms. Bilinear and multilinear forms.
415 Applied Linear Algebra
Fall, Spring, Summer. 3(3-0) P: (MTH 235 or MTH 255H or MTH 340) and (MTH 309 or MTH 314) Not open to students with credit in MTH 414. Matrices and linear algebra. General linear systems of equations. Least squares minimization techniques. Eigenvalues and eigenvectors, spectral decompositions, and exponentials.

416 Introduction to Algebraic Coding
Fall. 3(3-0) P: MTH 309. Concepts and techniques of abstract algebra applied to the design of communication systems for use in imperfect circumstances. Theory of codes designed by algebraic means.

417 Topics in Number Theory
Spring of even years. 3(3-0) P: MTH 310 Congruences of higher degree, primitive roots and quadratic reciprocity. Number-theoretic functions, algebraic numbers. Dirichlet Series, p-order expansion, continued fractions.

418H Honors Algebra I
Fall. 3(3-0) P: Completion of Tier I writing requirement. RB: MTH 309 R: Approval of department. Not open to students with credit in MTH 411. Theory of groups, Sylow theory, the structure of finite Abelian groups, ring theory, ideals, homomorphisms, and polynomial rings.

419H Honors Algebra II
Spring. 3(3-0) P: MTH 418H R: Approval of department. Algebraic field extensions, Galois theory. Classification of finite fields. Fundamental Theorem of Algebra.

421 Analysis II
Fall, Spring. 3(3-0) P: (MTH 320 or MTH 327H) and (MTH 234 or MTH 254H or LB 220) Continuation of MTH 320. Riemann integral. Metric spaces. Differentiation in higher dimensions. Inverse and implicit function theorems.

425 Complex Analysis
Fall, Spring. 3(3-0) P: MTH 320 Analytic functions of a complex variable, Cauchy integral theorem, conformal maps, bilinear transformation, harmonic functions. Classification of singularities, residues, conformal mappings.

428H Honors Complex Analysis
Fall. 3(3-0) P: MTH 327H R: Approval of department. Analytic functions of a complex variable, line integrals and harmonic functions, Cauchy's theorem and integral formula, power series, Laurent series, isolated singularities, residue calculus, Rouche's theorem, automorphisms of the disk, the Riemann mapping theorem.

429H Honors Real Analysis
Spring. 3(3-0) P: MTH 327H R: Approval of department. Not open to students with credit in MTH 421. Continuation of 327H. Convergence of sequences and series of functions, differentiation and integration in higher dimensional settings. Inverse and implicit function theorems.

432 Axiomatic Geometry
Spring. 3(3-0) P: MTH 309 Axiomatic systems and finite geometries: axioms of Euclidean and hyperbolic geometry, the Poincare model, independence of the parallel postulate. Classical constructions and the impossibility of angle trisection.

441 Ordinary Differential Equations II
Fall. 3(3-0) P: (MTH 235 or MTH 255H or MTH 340 or MTH 347H) and (MTH 309 or MTH 317H or MTH 314 or MTH 415) Existence and uniqueness theorems; Linearization; Local and global stability; Saddle-node, Hopf and heteroclinic bifurcations; Hamiltonian and gradient system; The Poincare map; The Poincare-Bendixon theorem and limit cycles; Selected applications.

442 Partial Differential Equations
Spring. 3(3-0) P: MTH 235 or MTH 255H or MTH 340 or MTH 347H Classification of second order partial differential equations. Boundary and initial value problems for heat, Laplace, and wave equations in dimensions 1, 2 and 3. Variational methods and maximum principles. Separation of variables, Fourier series, Sturm-Liouville theory. Greens functions.

443 Boundary Value Problems for Engineers
Fall. 3(3-0) P: MTH 235 or MTH 255H R: Not open to students in the Department of Mathematics. Description of separation of variables for partial differential equations. Sturm-Liouville problems.

451 Numerical Analysis I
Fall. 3(3-0) P: (CSE 131 or CSE 231) and (MTH 309 or MTH 314 or MTH 317H or MTH 415) and (MTH 235 or MTH 255H or MTH 340 or MTH 347H) SA: MTH 351 Numerical solution of linear and nonlinear algebraic equations and eigenvalue problems. Curve fitting. Interpolation theory. Numerical integration, differentiation, and solution of differential equations. Algorithms implementation with a programming language like Fortran, C/C++ or MATLAB.

452 Numerical Analysis II

455 Actuarial Models I
Fall. 3(3-0) Interdepartmental with Statistics and Probability. Administered by Statistics and Probability. RB: STT 441 and MTH 360 Stochastic models used in insurance. Survival distributions, life insurance, life annuities, benefit premiums, benefit reserves, and analysis of benefit reserves.

456 Actuarial Models II

457 Introduction to Financial Mathematics
Spring. 3(3-0) P: MTH 309 and (MTH 340 or MTH 235 or MTH 255H) and (STT 441 or STT 351) Mathematical overview of basic financial instruments. A unified partial differential equation approach to model derivative securities. Partial differential equations in financial mathematics, Black-Scholes equation. Numerical methods for valuing derivatives.

458 Financial Mathematics for Actuaries

459 Construction and Evaluation of Actuarial Models

461 Metric and Topological Spaces
Fall. 3(3-0) P: MTH 320 or MTH 428H Set theory, metric spaces, topological spaces, basic introductory point set topology. Connected and compact spaces, separation axioms, pointwise and uniform convergence.

462 Discrete Mathematics II
Spring. 3(3-0) P: MTH 481 RB: MTH 310 Recurrence and generating functions, Ramsey theory. Block designs, Latin squares, Eulerian and Hamiltonian paths. Minimum spanning trees, network flows.

490 Directed Studies
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Approval of department. Faculty directed study in a selected mathematical topic.

491A Actuarial Internship
Summer. 3(3-0) RB: STT 441 and FI 311 and MTH 360 Approval of department. Survey of typical actuarial type projects at an actuarial firm such as data analysis, risk analysis, interest rate models, life insurance, benefit programming, analysis of benefit reserves.

491B Teamwork Experience
Fall, Spring. 1(1-0) R: Approval of department. A field type experience to develop communication skills working in a group setting on multi-faceted projects.

496 Capstone in Mathematics
Fall, Spring. 3(3-0) P: Completion of Tier I writing requirement. R: Approval of department. A capstone course integrating several areas of mathematics
Mathematics—MTH

810  Error-Correcting Codes
Spring. 3(3-0) RB: MTH 411 or MTH 414 or MTH 415
Block codes, maximum likelihood decoding, Shannon's theorem. Generalized Reed-Solomon codes, modification of codes, subset field codes. Alterant and Goppa codes, cyclic codes and BCH codes.

818  Algebra I
Fall. 3(3-0) RB: MTH 411
Group theory: Sylow theory, permutation groups, Jordan-Hoelder theory, Abelian groups, free groups. Ring theory: algebra of ideals, unique factorization, polynomial rings, finitely generated modules over PID's.

819  Algebra II
Spring. 3(3-0) RB: MTH 818
Modules and vector spaces, projective modules, tensor algebra. Fields and Galois groups, algebraic and transcendental numbers, non-commutative rings. The Jacobson radical, the structure of semi-simple rings with the descending chain condition.

828  Real Analysis I
Fall. 3(3-0) RB: MTH 421 and MTH 461

829  Complex Analysis I
Spring. 3(3-0) RB: MTH 421 and MTH 425

840  Chaos and Dynamical Systems
Spring. 3(3-0) RB: (MTH 441 and MTH 320 and MTH 414) and some experience with mathematical software such as Mathematica, Matlab, etc.) and (MTH 421 and MTH 442) and (MTH 421 and MTH 442 and MTH 843) R: Open only to masters students in the Industrial Mathematics major or approval of department.
Participation as a member of a 3-4 person team on a significant industrial problem, with participation of an industrial liaison, including project report generation and reporting.

844  Projects in Industrial Mathematics
Spring. 3(3-0) RB: (MTH 414 or MTH 415) or some familiarity with mathematical software such as Mathematica or Matlab. and (MTH 421 and MTH 442 and MTH 843) R: Open only to masters students in the Industrial Mathematics major or approval of department.

848  Ordinary Differential Equations
Fall. 3(3-0) RB: MTH 414 and MTH 421

849  Partial Differential Equations
Spring. 3(3-0) RB: MTH 414 and MTH 421

850  Numerical Analysis I
Fall. 3(3-0) RB: MTH 414 and MTH 421
Convergence and error analysis of numerical methods in applied mathematics.

851  Numerical Analysis II
Spring. 3(3-0) RB: MTH 850

852  Numerical Methods for Ordinary Differential Equations
Fall. 3(3-0) RB: MTH 851

864  Geometric Topology
Spring. 3(3-0) RB: MTH 421 SA: MTH 464
Topology of surfaces and higher dimensional manifolds, studied from combinatorial, algebraic or differential viewpoints.

868  Geometry and Topology I
Fall. 3(3-0) RB: (MTH 411 and MTH 421) or approval of department.

869  Geometry and Topology II
Spring. 3(3-0) RB: MTH 868
Continuation of MTH 868.

879  Teaching College Mathematics
Fall of even years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.
Curriculum materials, case studies, approaches to teaching and student learning of particular mathematics topics.

880  Combinatorics
Fall. 3(3-0) RB: MTH 411 or MTH 482
Enumerative combinatorics, recurrence relations, generating functions, asymptotics, applications to graphs, partially ordered sets, generalized Moebius inversions, combinatorial algorithms.

881  Graph Theory
Spring. 3(3-0) RB: MTH 880
Graph theory, connectivity, algebraic and topological methods. Networks, graph algorithms, Hamiltonian and Eulerian graphs, extremal graph theory, random graphs.

890  Readings in Mathematics
Fall. Spring. Summer. 1 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course. R: Approval of department.
Individualized study for Master's level students.

910  Commutative Algebra I
Fall of odd years. 3(3-0) RB: MTH 819
Noetherian rings and modules, localization and tensor products, primary decomposition, Krull dimensions, graded rings and modules, Hilbert's Nullstellensatz, integral extensions, discrete valuation rings, Dedekind domains.

911  Combinatorial Algebra II
Spring of even years. 3(3-0) RB: MTH 910
Ext and Tor, regular sequences, Cohen-Macaulay rings, regular rings, Gorenstein rings, completion, modules of differentials, Cohen's structure theorems.

912  Group Theory I
Fall of even years. 3(3-0) RB: MTH 819
Permutation groups, solvable and nilpotent groups, simple groups. Representation and character theory. Extension theory and cohomology groups.

913  Group Theory II
Spring of odd years. 3(3-0) RB: MTH 912
Groups of Lie type, linear groups, locally finite groups, free groups and free products, the subgroup theorems.

914  Lie Groups and Algebras I
Fall of odd years. 3(3-0) RB: MTH 819
Nilpotent and semisimple algebras, the adjoint representation, root spaces, Weyl groups, Dynkin diagrams, classification of simple algebras.

915  Lie Groups and Algebras II
Spring of even years. 3(3-0) RB: MTH 914
Weights, symmetric spaces, groups of Lie type, finite groups of Lie type, Lang's theorem.

916  Introduction to Algebraic Geometry I
Fall of even years. 3(3-0) RB: MTH 818 and MTH 819
Affine and projective algebraic varieties and their properties. Morphisms and singularities. Schemes and coherent sheaves. Sheaf cohomology and other related topics.
917 Introduction to Algebraic Geometry II
Spring of odd years. 3(3-0) RB: MTH 916
Continuation of MTH 916.

920 Functional Analysis I
Spring. 3(3-0) RB: MTH 828
Hilbert spaces: Riesz representation theorem, Par-
seval's identity, Riesz-Fischer theorem, Fourier series
operators. Banach spaces: Hahn-Banach theorem,
open mapping and closed graph theorems, Banach-
Steinhaus theorem.

921 Functional Analysis II
Fall of even years. 3(3-0) RB: MTH 829 and
MTH 920
Topological vector spaces, convexity, Krein-Milman
theorem, Banach algebras, operators on Banach
spaces, spectral theorem, C*-algebras.

922 Harmonic Analysis
Fall of odd years. 3(3-0) RB: MTH 829 and
MTH 920
Fourier series, mean and pointwise convergence,
conjugate functions, Fourier transform, Plancherel
theorem, Paley-Wiener theorem, interpolation of
operators, Hausdorff-Young theorem.

923 Proseminar in Mathematics Education I
Fall of even years. 3(3-0) Interdepartmental
with Counseling, Educational Psychology and
Special Education and Mathematics Education and
Teacher Education. Administered by Mathematics Education. SA: SME 926
Research on the learning and teaching of mathem-
atics. Focus on curriculum, discourse, equity and
teacher education.

924 Proseminar in Mathematics Education II
Fall of even years. 3(3-0) Interdepartmental
with Counseling, Educational Psychology and
Special Education and Mathematics Education and
Teacher Education. Administered by Mathematics Education. SA: SME 927
Research on the learning and teaching of mathe-
matics. Focus on teaching, student learning, as-
essment and policy.

925 Complex Manifolds I
Fall of odd years. 3(3-0) RB: MTH 829 and
MTH 869
Riemann surfaces, Serre duality, Riemann-Roch
theorem, Weierstrass points, Abel's theorem, Plucker
formulas, Hermitian metrics, connections, curva-
ture, Hodge theorem. Kaehler metrics, Kodaira
vanishing theorem, Chern classes.

926 Complex Manifolds II
Spring of even years. 3(3-0) RB: MTH 935
Continuation of MTH 935.

940 Applied Analysis I
Fall. 3(3-0) RB: MTH 828
Sobolev spaces, trace theorem, imbedding theo-
rems, sectorial forms. Linear elliptic boundary and
eigenvalue problems.

941 Applied Analysis II
Spring. 3(3-0) RB: MTH 940
Fixed point theorems. Variational methods. Applica-
tions to nonlinear integral and elliptic differential
equations. Semigroup theory.

942 Foundations of Applied Mathematics I
Fall. 3(3-0) RB: MTH 848 and MTH 849
Modeling in classical applied mathematics. Newton-
ian and continuum mechanics. Special mathemati-
ical techniques.

943 Foundations of Applied Mathematics II
Spring. 3(3-0) RB: MTH 942
Continuation of MTH 942.

950 Numerical Methods for Partial Differential
Equations I
Spring of odd years. 3(3-0) RB: MTH 852
Finite difference methods for ordinary and partial
differential equations.

951 Numerical Methods for Partial Differential
Equations II
Spring of even years. 3(3-0)
Finite element methods for ordinary and partial
differential equations.

954 Design and Methods in Mathematics
Education Research
Fall. 3(3-0) Interdepartmental with Counsel-
ing, Educational Psychology and Special Education and
Teacher Education. Administered by Math-
ematics Education. RB: (MTH 927) and at
least one approved research methods course. SA: SME 954
History, current trends, and issues pertaining to
research design and methods in mathematics edu-
cation research. Mathematics education research in
the areas of policy, teaching, teacher training, and
student learning with particular attention to how
research design influence research findings.

960 Algebraic Topology I
Fall. 3(3-0) RB: MTH 869
Cohomology, products, duality, basic homotopy
theory, bundles, obstruction theory, spectral se-
quences, characteristic classes, and other related
topics.

961 Algebraic Topology II
Spring. 3(3-0) RB: MTH 960
Continuation of MTH 960.

990 Reading in Mathematics
Fall, Spring, Summer. 1 to 3 credits. A stu-
dent may earn a maximum of 9 credits in all enroll-
ments for this course. R: Approval of
department.

MTH—Mathematics