MATH 825 - Algebra and Functions for K-8 Mathematics Teachers
Credits: 3
Representation and analysis of mathematical situations and structures using generalization and algebraic symbols and reasoning. Attention is given to the transition from arithmetic to algebra, working with quantitative change, and the description and prediction of change. Credit offered only to M.Ed., M.A.T., Elementary Math Specialist certificate only students, and in-service teachers. Prereq: MATH 621 or MATH 821, permission. Not offered for credit if credit received for MATH 625.

MATH 826 - Rational Numbers and Proportional Reasoning for K-8 Mathematics Teachers
Credits: 3
Goal of this course is to prepare the K-8 mathematics teachers with sufficient mathematical knowledge for effective teaching of rational numbers and proportional reasoning. Attention is given to developing connections among a range of mathematical topics related to proportional reasoning, and the learning to assess elementary students' thinking about these topics. Credit offered only to M.Ed., M.A.T., Elementary Math Specialist certificate only students, and in-service teachers. Prereq: MATH 621 or MATH 821, permission.

MATH 836 - Advanced Statistical Methods for Research
Credits: 3
An introduction to multivariate statistical methods, including principal components, discriminant analysis, factor analysis, multidimensional scaling, and MANOVA. Additional topics include: PCA, multiple linear regression, analysis of cross classified categorical data, logistic regression, nonparametric statistics and data mining using CART. The use of statistical software, such as JMP, S PLUS, or R, is fully integrated into the course.

MATH 837 - Statistical Methods for Research
Credits: 3
This course provides a solid grounding in modern applications of statistics to a wide range of disciplines by providing an overview of the fundamental concepts of statistical inference and analysis, including t-tests and confidence intervals. Additional topics include: ANOVA, multiple linear regression, analysis of cross classified categorical data, logistic regression, nonparametric statistics and data mining using CART. The use of statistical software, such as JMP, S PLUS, or R, is fully integrated into the course.

MATH 838 - Advanced Statistical Methods for Research
Credits: 3
An introduction to multivariate statistical methods, including principal components, discriminant analysis, cluster analysis, factor analysis, multidimensional scaling, and MANOVA. Additional topics include: generalized linear models, general additive models, depending on the interests of class participants. This course completes a solid grounding in modern applications of statistics used in most research applications. The use of statistical software, such as JMP, S PLUS, or R, is fully integrated into the course. Prereq: MATH 835 or MATH 839.
MATH 837 - Statistical Methods for Quality Improvement and Design
Credits: 3
Six Sigma is a popular, data-focused methodology used worldwide by
organizations to achieve continuous improvement of their existing
processes, products and services or to design new ones. This course
provides a thorough introduction to the Six Sigma principles, methods,
and applications for continuous improvement (DMAIC process) and an
overview of Design for Six Sigma (DFSS). Both manufacturing and non-
manufacturing (transactional Six Sigma) applications will be included.
Emphasis is placed on the use of case studies to motivate the use of, as
well as the proper application of, the Six Sigma methodology. Formal Six
Sigma Green Belt certification from UNH may be attained by successfully
completing TECH 696. Prereq: MATH 539, MATH 644; or permission.

MATH 838 - Data Mining and Predictive Analytics
Credits: 3
An introduction to supervised and unsupervised methods for exploring
large data sets and developing predictive models. Unsupervised methods
include: market basket analysis, principal components, clustering,
and variables clustering. Important statistical and machine learning
methods (supervised learning) include: Classification and Regression
Tress (CART), Random Forests, Neural Nets, Support Vector Machines,
Logistic Regression and Penalized Regression. Additional topics focus
on metamodeling, validation strategies, bagging and boosting to improve
prediction or classification, and ensemble prediction from a set of diverse
models. Required case studies and projects provide students with
experience in applying these techniques and strategies. The course
necessarily involves the use of statistical software and programming
languages. Prereq: MATH 539 (or MATH 644); or permission.

MATH 839 - Applied Regression Analysis
Credits: 3
Statistical methods for the analysis of relationships between response
and input variables: simple linear regression, multiple regression analysis,
residual analysis model selection, multi-collinearity, nonlinear curve
fitting, categorical predictors, introduction to analysis of variance,
analysis of covariance, examination of validity of underlying assumptions,
logistic regression analysis. Emphasizes real applications with use of
statistical software. Prereq: basic introductory statistics.

MATH 840 - Design of Experiments I
Credits: 3
First course in design of experiments with applications to quality
improvement in industrial manufacturing, engineering research and
development, or research in physical and biological sciences.
Experimental factor identification, statistical analysis and modeling
of experimental results, randomization and blocking, full factorial
designs, random and mixed effects models, replication and sub-sampling
strategies, fractional factorial designs, response surface methods,
mixture designs, and screening designs. Focuses on various treatment
structures for designed experimentation and the associated statistical
analyses. Use of statistical software. Prereq: basic introductory
statistics; permission.

MATH 841 - Survival Analysis
Credits: 3
Explorations of models and data-analytic methods used in medical,
biological, and reliability studies. Event-time data, censored data,
reliability models and methods, Kaplan-Meier estimator, proportional
hazards, Poisson models, loglinear models. The use of statistical
software, such as SAS, JMP or R, is fully integrated into the course.
Prereq: MATH 839. (Offered in alternate years.)

MATH 842 - Time Series Analysis
Credits: 3
An introduction to univariate time series models and associated methods
of data analysis and inference in the time domain and frequency domain.
Topics include: Auto regressive (AR), moving average (MA), ARMA and
ARIMA processes, stationary and non-stationary processes, seasonal
ARIMA processes, auto-correlation and partial auto-correlation functions,
identification of models, estimation of parameters, diagnostic checking
of fitted models, forecasting, spectral density function, periodogram and
discrete Fourier transform, linear filters. parametric spectral estimation,
dynamic Fourier analysis. Additional topics may include wavelets and
long memory processes (FARIMA) and GARCH Models. The use of
statistical software, such as JMP, or R, is fully integrated in to the course.
Prereq: MATH 835 or MATH 839. Offered in alternate years in the spring.

MATH 843 - Design of Experiments II
Credits: 3
Second course in design of experiments, with applications in quality
improvement and industrial manufacturing, engineering research and
development, research in physical and biological sciences. Covers
experimental design strategies and issues that are often encountered in
practice complete and incomplete blocking, partially balanced incomplete
blocking (PBIB), partial confounding, intra and inter block information,
split plotting and strip plotting, repeated measures, crossover designs,
Latin squares and rectangles, Youden squares, crossed and nested
treatment structures, variance components, mixed effects models,
analysis of covariance, optimizations, space filling designs, and modern
screening design strategies. Prereq: MATH 840; or permission.

MATH 844 - Foundations of Applied Mathematics I
Credits: 3
An introduction to Partial Differential Equations (PDEs) and associated
mathematical methods and the analytical foundation for applied
mathematics. Topics include: PDE classification, superposition,
separation of variables, orthonormal functions, completeness,
convergence, Fourier Series, Sturm-Liouville eigenvalue problems, and
eigenfunctions. Methods are introduced for the analysis and solution
of boundary value problems, in particular, the Heat, Wave, and Laplace
equations. Prereq: Multi-dimensional calculus and ordinary differential
equations.

MATH 845 - Foundations of Applied Mathematics II
Credits: 3
An introduction to special functions, asymptotic analysis, and transform
methods applied to partial differential equations. Topics include:
Boundary value problems in cylindrical coordinates, the Bessel equation
and Bessel functions, Fourier-Bessel expansions in cylindrically
symmetric spatial domains, the Fourier Transform, the Hilbert Transform,
Cosine and Sine Transforms, problems on semi-infinite intervals, and
Asymptotic Analysis. Prereq: Multi-dimensional calculus and ordinary
differential equations.

MATH 847 - Introduction to Nonlinear Dynamics and Chaos
Credits: 3
An introduction to the mathematics of chaos and nonlinear dynamics.
Topics include: linear and nonlinear systems of ordinary differential
equations; discrete maps; chaos; phase plane analysis; bifurcations; and
computer simulations. Prereq: elementary differential equations; linear
algebra; and multidimensional calculus. (Not offered every year.)
MATH 853 - Introduction to Numerical Methods  
Credits: 3  
Introduction to mathematical algorithms and methods of approximation. A wide survey of approximation methods are examined including, but not limited to, polynomial interpolation, root finding, numerical integration, approximation of differential equations, and techniques used in conjunction with linear systems. Included in each case is a study of the accuracy and stability of a given technique, as well as its efficiency and complexity. It is assumed that the student is familiar and comfortable with programming a high-level computer language. (Also offered as CS 853.)

MATH 855 - Probability with Applications  
Credits: 3  
Introduces the theory, methods, and applications of randomness and random processes. Probability concepts, random variable, expectation, discrete and continuous probability distributions, joint distributions, conditional distributions; moment-generating functions, convergence of random variables.

MATH 856 - Abstract Algebra  
Credits: 3  
This course establishes the axiomatic framework that underlies number systems and similar mathematical structures, investigating basic properties of groups, rings, fields and their homomorphisms.

MATH 857 - One-Dimensional Real Analysis  
Credits: 3  
Theory of limits, continuity, differentiability, integrability.

MATH 858 - Real Analysis II  
Credits: 3

MATH 859 - Introduction to Differential Geometry  
Credits: 3  
Introduction to the study of the geometric properties of curves and surfaces in 3-dimensional space.

MATH 860 - Foundations of Number Theory  
Credits: 3  
Factorization and prime numbers, arithmetic functions, congruences, reciprocity laws, quadratic forms, Diophantine equations, computational number theory. Offered in alternate years.

MATH 861 - Abstract Algebra II  
Credits: 3  
A wide survey of approximation methods are examined including, but not limited to, polynomial interpolation, root finding, numerical integration, approximation of differential equations, and techniques used in conjunction with linear systems. Included in each case is a study of the accuracy and stability of a given technique, as well as its efficiency and complexity. It is assumed that the student is familiar and comfortable with programming a high-level computer language. (Also offered as CS 853.)

MATH 862 - Linear Algebra  
Credits: 3  

MATH 863 - Abstract Algebra II  
Credits: 3  
This course extends the investigations of MATH 861 into more specialized situations related to old and new problems in mathematics, such as the nature of solutions of polynomial equations. It presents advanced properties of groups, rings, fields and their applications. Prereq: MATH 861.

MATH 864 - Introduction to Commutative Algebra and Algebraic Geometry  
Credits: 3  
Methods of determining solution sets of polynomial systems; affine varieties and their ideals; the 'algebra-geometry correspondence'; theory and applications of Grobner bases.

MATH 865 - Introduction to Commutative Algebra and Algebraic Geometry  
Credits: 3  
Methods of determining solution sets of polynomial systems; affine varieties and their ideals; the 'algebra-geometry correspondence'; theory and applications of Grobner bases.

MATH 866 - Introduction to Differential Geometry  
Credits: 3  
Introduction to the study of the geometric properties of curves and surfaces in 3-dimensional space.

MATH 867 - One-Dimensional Real Analysis  
Credits: 3  
Theory of limits, continuity, differentiability, integrability.

MATH 868 - Real Analysis II  
Credits: 3

MATH 869 - Introduction to Differential Geometry  
Credits: 3  
Introduction to the study of the geometric properties of curves and surfaces in 3-dimensional space.

MATH 870 - Foundations of Number Theory  
Credits: 3  
Factorization and prime numbers, arithmetic functions, congruences, reciprocity laws, quadratic forms, Diophantine equations, computational number theory. Offered in alternate years.

MATH 871 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 872 - Combinatorics  
Credits: 3  
Graph theory (including planar graphs, graph coloring, Hamiltonian circuits, trees); counting principles (including permutations, combinations, pigeonhole principle, inclusion-exclusion principle); and related topics.

MATH 873 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 874 - Combinatorics  
Credits: 3  
Graph theory (including planar graphs, graph coloring, Hamiltonian circuits, trees); counting principles (including permutations, combinations, pigeonhole principle, inclusion-exclusion principle); and related topics.

MATH 875 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 876 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 877 - Combinatorics  
Credits: 3  
Graph theory (including planar graphs, graph coloring, Hamiltonian circuits, trees); counting principles (including permutations, combinations, pigeonhole principle, inclusion-exclusion principle); and related topics.

MATH 878 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 879 - Combinatorics  
Credits: 3  
Graph theory (including planar graphs, graph coloring, Hamiltonian circuits, trees); counting principles (including permutations, combinations, pigeonhole principle, inclusion-exclusion principle); and related topics.

MATH 880 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 881 - Combinatorics  
Credits: 3  
Graph theory (including planar graphs, graph coloring, Hamiltonian circuits, trees); counting principles (including permutations, combinations, pigeonhole principle, inclusion-exclusion principle); and related topics.

MATH 882 - Logic  
Credits: 3  
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. (Not offered every year.)

MATH 883 - Set Theory  
Credits: 3  
Axiomatic set theory, including its history, Zermelo-Fraenkel axioms, ordinal and cardinal numbers, consistency, independence, and undecidability. (Not offered every year.)

MATH 884 - Topology  
Credits: 3  
Open sets, closure, base, and continuous functions. Connectedness, compactness, separation axioms, and metrizability.

MATH 885 - Complex Analysis  
Credits: 3  

MATH 886 - Topics in Mathematics and Statistics  
Credits: 1-4  
New or specialized courses not covered in regular course offerings. Prereq: permission of instructor. May be repeated.

MATH 887 - Master's Project  
Credits: 1-6  
May be repeated to a maximum of 6 credits. IA (continuous grading). Cr/F.

MATH 888 - Master's Thesis  
Credits: 1-6  
May be repeated up to a maximum of 6 credits. Cr/F.
MATH 900 - Bridges from the Classroom to Mathematics  
Credits: 1  
An introduction to the goals of the MST program. Students have the opportunity to explore mathematical problems; to complete activities that make connections between several areas of mathematics, including the mathematical content in the MST degree program and the secondary school mathematics classroom; and to participate in readings/on-line discussion on the nature of mathematics. Permission required. Cr/F.

MATH 902 - Classroom Mathematics Practicum  
Credits: 1  
A follow-up course to the six core mathematics content courses of the MST degree program. During the course, students choose a mathematical topic and/or set of concepts learned in one of the core MST courses and develop and teach a unit based on these concepts at the middle school or secondary school level. Permission required. Cr/F.

MATH #903 - Algebraic Structures  
Credits: 3  
An exploration of the structural similarities between and among seemingly disparate number systems, beginning with counting numbers, and progressing to integers, the rational numbers, the real numbers, and the complex numbers; and leading to a discussion of polynomials as an integer analogue and to fields as polynomial "quotients" through the basic concepts of splitting fields and Galois Theory. Permission required.

MATH 905 - Euclidean and non-Euclidean Geometries from a Synthetic Perspective  
Credits: 3  
An axiomatic development of geometry, beginning with finite geometries; emphasis is given to the fundamental concepts of Euclidean and non-Euclidean geometries from a synthetic perspective. Permission required.

MATH 906 - Analytic and Transformational Geometry  
Credits: 3  
Fundamental concepts of transformational, projective geometry, and inversive geometry, including properties of conics and quadratic surfaces. Permission required.

MATH #907 - Real Analysis  
Credits: 3  
An introduction to the fundamental concepts in real analysis that provide the mathematical foundation for calculus. Content focuses on properties of sequences and series; properties of functions, including continuity, the derivative and the Riemann integral. Permission required.

MATH 909 - Probability and Statistics for Teachers  
Credits: 3  
Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications.

MATH 910 - Selected Topics in Mathematics Education for Teachers  
Credits: 1-4  
Current developments and issues in mathematics education; content, curricula, methods, and psychology of teaching mathematics. Can be repeated for credit.

MATH 913 - Graph Theory and Topics in Discrete Mathematics  
Credits: 3  
Key theoretical and computational aspects of graph theory and related areas of discrete mathematics. Applications of graph theory as well as current "open" problems are explored. Permission required.

MATH 914 - Topology for Teachers  
Credits: 3  
Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations.

MATH 915 - Algebraic Structures  
Credits: 3  
An exploration of the structural similarities between and among seemingly disparate number systems, beginning with counting numbers, and progressing to integers, the rational numbers, the real numbers, and the complex numbers; and leading to a discussion of polynomials as an integer analogue and to fields as polynomial "quotients" through the basic concepts of splitting fields and Galois Theory. Permission required.

MATH 916 - Theory of Numbers for Teachers  
Credits: 3  
Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; perfect and amicable numbers.

MATH 917 - Mathematical Proof and Problem Solving  
Credits: 3  
Introduction to abstract mathematics with an emphasis on problem solving and proof structure, methods and techniques. Content includes logic, set theory and basic number theory.

MATH 918 - Analysis of Real Numbers  
Credits: 3  
An introduction to the fundamental concepts in real analysis that provide the mathematical foundation for calculus. Content focuses on properties of sequences and series; properties of functions, including continuity, the derivative and the Riemann integral. Permission required.

MATH #920 - History of Mathematics  
Credits: 3  
A problem-study approach to mathematical problems from the period of Greek mathematics until the modern era.

MATH 925 - Problem Solving Seminar  
Credits: 1-3  
New or specialized topics not covered in the regular course offerings. May be repeated for credit.

MATH 929 - Directed Reading  
Credits: 1-3  
A directed reading project on a selected topic in mathematics or mathematics education, planned in collaboration with a faculty member. May be repeated up to 6 credits.

MATH 931 - Mathematical Physics  
Credits: 3  
Complex variables, differential equations, asymptotic methods, integral transforms, special functions, linear vector spaces and matrices, Green's functions, and additional topics selected from integral equations, variational methods, numerical methods, tensor analysis, and group theory. Prereq: differential equations; linear algebra; multidimensional calculus. (Also offered as PHYS 931.)
MATH 941 - Bayesian and Computational Statistics  
Credits: 3  
Current approaches to Bayesian modeling and data analysis and related statistical methodology based on computational simulation. Fundamentals of Bayesian estimation and hypothesis testing. Multilevel and hierarchical Bayesian modeling for correlated data. Introduction to Markov chain Monte Carlo based estimation approaches such as the Gibbs sampler and the Metropolis-Hastings algorithm. Prereq: knowledge of intermediate statistics: distributions, discrete and continuous random variables, transformation of variables (calculus based), bivariate and multivariate normal distribution, maximum likelihood estimation; working knowledge of linear regression and analysis of variance; basic linear algebra: vectors and matrices, linear spaces, matrix multiplication, inverse of a matrix, positive definiteness. Matrix-vector notation for linear regression and ANOVA.

MATH 944 - Spatial Statistics  
Credits: 3  

MATH 945 - Advanced Theory of Statistics I  
Credits: 3  

MATH 946 - Advanced Theory of Statistics II  
Credits: 3  

MATH 951 - Algebra I  
Credits: 3  
Groups and their homomorphisms, products and sums, structure of groups; rings and their homomorphisms, ideals, factorization properties. Prereq: MATH 861.

MATH 952 - Algebra II  
Credits: 3  
Field extensions; Galois theory; module theory. Prereq: MATH 951.

MATH 953 - Analysis I  
Credits: 3  
Measurable spaces and functions, measures, Lebesgue integrals, convergence theorems. Prereq: MATH 867.

MATH 954 - Analysis II  
Credits: 3  
Cauchy theory and local properties of analytic functions, Riemann mapping theorem, representation theorems, harmonic functions. Prereq: MATH 888.

MATH 955 - Topology I  
Credits: 3  
Subspace, product, and quotient topologies; embedding; separation and countability axioms; connectedness; compactness and compactifications; paracompactness, metrization, and metric completions. Prereq: MATH 884.

MATH 956 - Topology II  
Credits: 3  
Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products. Prereq: MATH 861 and MATH 884.

MATH 958 - Foundations of Math Education  
Credits: 3  
Topics will include: major issues, trends, and programs in mathematics education research, the research process, theoretical perspectives to guide research, the profession and infrastructure of mathematics education, cultural and historical aspects of mathematics education, and the research-practice interface. Examples span the K-16 spectrum. Prereq: permission.

MATH 961 - Topics in Algebra I  
Credits: 3  
An introduction to topics chosen from algebra and number theory. Prereq: MATH 951-MATH 952. May be repeated.

MATH 964 - Topics in Analysis I  
Credits: 3  
An introduction to topics in analysis. Prereq: permission. May be repeated.

MATH 965 - Topics in General Topology I  
Credits: 3  
An introduction to topics in general topology. Prereq: MATH 955. May be repeated.

MATH 966 - Topics in Algebraic Topology I  
Credits: 3  
An introduction to topics in algebraic topology. Prereq: MATH 956. May be repeated.

MATH 967 - Topics in Applied Mathematics I  
Credits: 3  
An introduction to topics in applied mathematics. Prereq: permission. May be repeated.
MATH 968 - Topics in Mathematics Education I  
Credits: 3  
A) The Teaching and Learning of Mathematics; B) Curriculum and History in Mathematics Education. Topics selected from: epistemologies of knowledge applied to mathematics; theories of learning and teaching mathematics; theoretical perspectives in research; mathematics education research programs K-16; research methods for studying mathematics teaching, learning, and curricula; theoretical frameworks for curriculum development, implementation of new curricula, and research on curricula; historical perspectives of research in mathematics education; the evolution and history of K-16 mathematics curricula both in United States and internationally. Versions A and B offered alternately. Prereq: MATH 958 or permission. May be repeated.

MATH 969 - Topics in Probability and Statistics I  
Credits: 3  
Selected advanced topics from one or several of the following areas: probability, stochastic processes, design of experiments, biostatistics, Bayesian theory and methods, spatial and spatio-temporal statistics, time series analysis, nonparametric statistics. Prereq: permission. May be repeated.

MATH 971 - Topics in Algebra II  
Credits: 3  
An introduction to advanced topics chosen from algebra and number theory. Prereq: MATH 951 - MATH 952; permission. May be repeated.

MATH 973 - Topics in Operator Theory  
Credits: 3  
Selected topics in operator theory. Prereq: MATH 963. May be repeated.

MATH 977 - Topics in Applied Mathematics II  
Credits: 3  
An exploration of an area of research in applied mathematics. Prereq: permission. May be repeated.

MATH 978 - Topics in Mathematics Education II  
Credits: 3  
An exploration of an area of research in mathematics education. Prereq: permission. May be repeated.

MATH 979 - Research Topics in Statistics  
Credits: 3  
An exploration of the main statistical issues and computational methods associated with research problems from such areas as survival analysis, reliability, latitudinal data, categorical data, spatio-temporal data, and industrial processes. Student term projects require: literature searches, presentation, use of modern statistical software, and written reports. Prereq: permission. May be repeated.

MATH 997 - Statistics Seminar  
Credits: 1  
A seminar of weekly and bi-weekly meetings organized by the statistics Ph.D. students with supervision by a statistics faculty member. Informal presentations of faculty members, students, and outside guest presenters; also discussion of topics that are of mutual interest to its participants. Dissertation proposal presentations. Seminar presentations are open to the greater public. Statistics Ph.D. students are required to enroll for at least 3 semesters. Attendance is mandatory by those students who are wnooned in the seminar. Credits do not count towards the Master's degree. May be repeated to a maximum of 6 credits. Cr/F.

MATH 998 - Reading Courses  
Credits: 1-6  

MATH 999 - Doctoral Research  
Credits: 0  
Cr/F.