MATHEMATICS AND STATISTICS

The department of mathematics and statistics offers programs leading to the M.S. in applied mathematics, either with or without a thesis, the master of science for teachers degree, and the Ph.D. in Mathematics. The M.S. in applied mathematics can be pursued with either a mathematics or a statistics emphasis, while the Ph.D. in mathematics can be pursued with an emphasis in mathematics, computational and applied mathematics, or statistics. The M.S. is recommended, but not required, as a prerequisite for the Ph.D. If you intend to pursue the doctorate without obtaining a master's degree, during the first two academic years you are required to obtain at least 32 hours of graduate credit, with emphasis placed on subject areas that will provide you with a solid foundation in mathematics and/or statistics relevant to your chosen emphasis area. Specifically, these hours should be selected so that you will have obtained an introduction to (a) modern algebra, analysis, statistics and topology if selecting the mathematics emphasis, (b) real analysis, differential equations, partial differential equations, statistics as well as either complex analysis or modern algebra if choosing the computational and applied mathematics emphasis, and (c) linear algebra, probability, and statistical inference, if choosing the statistics emphasis.

The mathematics and statistics department also offers graduate certificates in actuarial science, statistical methods in psychology, and statistics.

Fellowships and graduate assistantships are available to qualified applicants. Detailed information about these opportunities may be obtained from the department chair or the director of graduate studies. Additional information is available electronically at: http://math.mst.edu/.

The department faculty and graduate students, along with graduate instruction and research activities, are housed in the Rolla Building. The Rolla Building, erected 1871, was the original home of the University of Missouri School of Mines and Metallurgy.

The program for the M.S. in Applied Mathematics without a thesis must include at least 30 hours of graduate credit, with the following additional specifications:

- At least 18 hours must come from Mathematics & Statistics Department lecture courses at the 5000-level or higher.
- At least 6 of the 18 hours must come from Mathematics & Statistics Department lecture courses at the 6000-level.
- A minimum of 3 additional hours must come from 6000-level lecture courses.

The program for the M.S. in Applied Mathematics with a thesis must include at least 30 hours of graduate credit, with the following additional specifications:

- At least 12 hours must come from Mathematics & Statistics Department lecture courses at the 5000-level or higher.
- At least 6 of the 12 hours must come from Mathematics & Statistics Department lecture courses at the 6000-level.
- At least 6 hours of Graduate Research (MATH 5099, MATH 6099, STAT 5099, or STAT 6099) must be completed.
- Candidates must pass an oral thesis defense.

All M.S. candidates are encouraged to include in their program courses in engineering or science that are closely related to their interests. For those intending to terminate study at the M.S. level, specializations supporting specific career goals are possible.

The master of science for teachers program is primarily designed for secondary school teachers in the physical sciences and mathematics. The program of study must include at least 30 hours of courses numbered at the 4000-level or above in science and mathematics, three hours of which must be at the 6000-level. A student may substitute up to six credit hours of coursework at the 3000 level in place of six hours of 4000 level courses; any such courses must be from departments other than mathematics and statistics and are subject to the approval of the student's master's committee.

A program for the Ph.D. degree includes about 30 hours of breadth in graduate level mathematics and statistics, about 30 hours of courses in or outside of the department representing a field of specialization, and a minimum of 30 hours devoted to the dissertation. In particular, the Ph.D. requires a total of at least 30 hours of Math/Stat 6099. Math/Stat 6099 hours used to complete an M.S. thesis cannot be counted toward the doctoral research requirements.

The specific program for a candidate is designed jointly by the candidate and the candidate's advisory committee. A qualifying examination, usually taken soon after completion of the M.S. degree or equivalent course work, is required. For those obtaining a doctoral degree with emphasis in Mathematics a reading knowledge of one modern foreign language, typically either French, German, or Russian, is required. Those whose doctoral emphasis is computational and applied mathematics, statistics, knowledge in a programming language such as C, C++, or FORTRAN and programming expertise demonstrated through an approved project is required. At times approved by the advisory committee, candidates must pass both written and oral comprehensive examinations. These examinations may cover courses outside the department. The dissertation is expected to represent original research and to meet the standard ordinarily required for publication in one of the journals devoted to reporting research in the selected field.

Graduate certificates are offered in the following:

Actuarial Science

Once admitted to the program, a student will be given three years to complete the program so long as he/she maintains a B average in the courses taken. To obtain the Graduate Certificate in Actuarial Science students must complete all of the requirements given in Parts I and II below, while maintaining a B average over all courses taken to satisfy these requirements.

Part I. Obtain a passing grade in all of the following courses:		
STAT 5644	Mathematical Statistics (*)	3
STAT 5755	Statistical Models in Actuarial Science	3
or ECON 4350	Statistical Models in Actuarial Science	
STAT 5756	Statistical Models for Life Contingencies	3
Part II. Obtain a passing grade in one of the following courses:		
STAT 5814	Applied Time Series Analysis	3
MATH 5737	Financial Mathematics	3
or ECON 5337	Financial Mathematics	
STAT 5643	Probability And Statistics	3
STAT 5346	Regression Analysis	3
or COMP SCI 5204	Regression Analysis	
STAT 5353	Statistical Data Analysis	3

STAT 6841	Stochastic Processes	3
ECON 4310	Mathematical Economics	3

All the above courses must be taken for graduate credit and cannot be counted towards requirements for an undergraduate degree. A grade of C or better will be considered a passing grade.

*Students who have taken STAT 5644 to satisfy one of the requirements of their undergraduate degree are allowed to replace this course with one of the courses listed in Part II above, provided the selected course is not also used to satisfy the one-course requirement or Part II.

Financial Mathematics

Three courses are required from the following:		
STAT 5814	Applied Time Series Analysis	3
or STAT 6814	Statistical Time Series Analysis	
STAT 6841	Stochastic Processes	3
MATH 5737	Financial Mathematics	3
MATH 6737	Financial Mathematics II	3
or ECON 6337	Financial Mathematics II	
One course is required from the following:		
ECON 5310	Advanced Mathematical Economics	3
ECON 5720	Advanced International Finance	3
ENG MGT 6212	Investment	3
ENG MGT 6213	Financial Engineering	3
STAT 5346	Regression Analysis	3
MATH 6665	Mathematical Programming	3

Statistical Methods in Psychology

This certificate program is designed to provide formalized education in the area of statistics as it is applied to the analysis of psychological data. Students will complete a four course sequence of classes designed to develop basic graduate level skills in psychological data analysis. These courses will develop an understanding of basic graduate level statistical concepts including probability, t-tests, ANOVAs, regression, as well as non-parametric tests. Students will engage in projects which include measure development and refinement procedures.

The following two psychology courses will be required:

PSYCH 5201	Psychometrics
PSYCH 5202	Applied Psychological Data Analysis

And an additional two statistics courses chosen from these four:

STAT 5346	Regression Analysis
STAT 5353	Statistical Data Analysis
STAT 5643	Probability And Statistics
STAT 6344	Design And Analysis Of Experiments

Students admitted to the certificate program will have a non-matriculated status as a graduate student. If they complete each of the four courses with a grade of B or better, they may be admitted to the Missouri S&T master's degree program in industrial-organizational psychology or mathematics and statistics if they apply and meet the program requirements. Students who do not have all of the prerequisite courses necessary to take a course in the certificate program will be allowed to take "bridge" courses at either the graduate or undergraduate level to prepare for the formal certificate courses.

Statistics

Program Description:

The department of mathematics and statistics offers a variety of theoretical and applied statistics courses that are taken by an appreciable number of graduate students from outside our department. Many of these students go on to take more than one graduate level statistics course during their academic career at S&T. They find these courses not only interesting, but also useful in their work as engineers and experimental scientists. This certificate program will enable these students to obtain credentials in an area that is outside their main discipline yet will be very useful in their practice as engineers and scientists. Such credentials will also set them apart from others within their discipline. In the past many of the students from engineering and sciences disciplines enrolled in our statistics courses have expressed great interest in obtaining a graduate certificate in statistics.

Admission:

The graduate certificate program is open to all individuals holding a BS degree in mathematics, statistics, or in an engineering or hard scientific discipline with a B average or better in coursework taken for the BS degree. In addition, the applicant must have a minimum of two years of professional experience or currently be accepted into a graduate degree program at Missouri S&T.

Students who are not currently enrolled in a graduate degree program at Missouri S&T but are admitted to the certificate program will have non-degree graduate status but will earn graduate credit for the courses they complete. The courses in the certificate program will be offered such that students can complete the program in a timely manner. The certificate courses taken by students admitted to the program will count towards any graduate degree offered by the department of mathematics and statistics if approved by the student's academic committee.

Once admitted to the program, a student will be given three years to complete the program as long as 3.0 grade point average is maintained in the courses taken.

Curriculum:

To obtain the graduate certificate in statistics students must select an option from the options given below and complete all of the requirements under that option by obtaining passing grades in all courses taken to satisfy the stipulated requirements while maintaining a 3.0 cumulative grade point average.

OPTION I-Foundations and Focused Applications

Required:		
STAT 5643	Probability And Statistics	3
STAT 5644	Mathematical Statistics	3
Select one of the three groups listed below and complete two of the courses in that group:		
GROUP 1- Modeling Empirical Processes		
STAT 5814	Applied Time Series Analysis	3
or STAT 6814	Statistical Time Series Analysis	
STAT 6841	Stochastic Processes	3
GROUP 2 - Classical Tools for Data Analysis		
STAT 5346/ COMP SCI 5204	Regression Analysis	3
STAT 5353	Statistical Data Analysis	3
STAT 6344	Design And Analysis Of Experiments	3
GROUP 3 - Advanced Topics in Statistical Methods and Modeling		
STAT 6239/ COMP ENG 6330/ ELEC ENG 6830/ SYS ENG 6214/ COMP SCI 6405	Clustering Algorithms	3

STAT 6343	Nonparametric Statistical Methods	3
STAT 6545	Multivariate Statistical Methods	3
STAT 6553	Linear Statistical Models I	3
STAT 6570	Theory Of Reliability	3

OPTION 2-Applied Statistics

Choose four courses from the following:		
STAT 5260	Statistical Data Analysis Using SAS	3
STAT 3425	Introduction to Biostatistics	4
STAT 5814	Applied Time Series Analysis	3
STAT 5346/ COMP SCI 5204	Regression Analysis	3
STAT 5353	Statistical Data Analysis	3
STAT 6239/ COMP ENG 6330/ ELEC ENG 6830/ SYS ENG 6214/ COMP SCI 6405	Clustering Algorithms	3
STAT 6343	Nonparametric Statistical Methods	3
STAT 6344	Design And Analysis Of Experiments	3
STAT 6545	Multivariate Statistical Methods	3
STAT 6570	Theory Of Reliability	3

OPTION III-Theory and Applications

Required:		
STAT 5643	Probability And Statistics	3
Choose three courses from the following:		
STAT 5260	Statistical Data Analysis Using SAS	3
STAT 3425	Introduction to Biostatistics	4
STAT 5814	Applied Time Series Analysis	3
STAT 5346/ COMP SCI 5204	Regression Analysis	3
STAT 5353	Statistical Data Analysis	3
STAT 6239/ COMP ENG 6330/ ELEC ENG 6830/ SYS ENG 6214/ COMP SCI 6405	Clustering Algorithms	3
STAT 6343	Nonparametric Statistical Methods	3
STAT 6344	Design And Analysis Of Experiments	3
STAT 6545	Multivariate Statistical Methods	3
STAT 6570	Theory Of Reliability	3

All the above courses listed in Options I, II, and III must be taken for graduate credit and cannot be counted towards requirements of an undergraduate degree.

Akim Mouhamadou Adekpedjou, Professor
PHD University of South Carolina Columbia
Recurrent event data analysis, stochastic processes, survival analysis.

Elvan Akin, Professor
PHD University of Nebraska Lincoln
The theory of time scales (unification of continuous and discrete analysis), infectious disease modeling on time scales (HIV-1, swine flu, tuberculosis, COVID-19), oscillation theory, dynamical systems, inequalities, stability theory, boundary value problems, control theory.

Martin Bohner, Curators' Distinguished Professor
PHD University of Ulm, Germany
Ordinary differential equations, dynamic equations on time scales, difference equations, Hamiltonian systems, variational analysis, boundary value problems, control theory, oscillation.

Stephen L Clark, Chancellor's Professor
PHD Univ. of Tennessee-Knoxville
Differential and difference equations, operator theory, direct and inverse spectral theory, inequalities.

David E Grow, Associate Professor
PHD University of Nebraska Lincoln
Analysis, Fourier analysis, lacunary series.

Daozhi Han, Assistant Professor
PHD Florida State University
Applied analysis of PDE's, numerical analysis and computation, fluid dynamics.

Xiaoming He, Associate Professor
PHD Virginia Polytechnic Institute
Finite elements, Interface problems, numerical methods for partial differential equations, computational fluid dynamics, computational electromagnetism, stochastic partial differential equations, extrapolations, boundary integral equations, feedback control.

Wenqing Hu, Assistant Professor
PHD University of Maryland-College Park
Stochastic analysis, stochastic differential equations, random dynamical systems, (stochastic) partial differential equations, high-dimensional statistics, statistical machine learning, optimization.

Eugene M Insall Jr, Associate Professor
PHD University of Houston
Logic, nonstandard methods, nonstandard models, algebra, topological algebra, topological model theory.

Vy Khoi Le, Professor
PHD University of Utah
Nonlinear differential equations, bifurcation, calculus of variations.

Jason Murphy, Assistant Professor
PHD University of California-Los Angeles
Harmonic analysis, nonlinear partial differential equations.

Gayla Renee Olbricht, Associate Professor
PHD Purdue University
Statistical genomics and epigenomics, hidden Markov models, modeling dependent data, mixed models.

Robert L Paige, Professor
PHD Colorado State University
Statistical shape analysis, topological data analysis.

V A Samaranayake, Chancellor's Professor
PHD Kansas State University
Time series analysis, data science, reliability, and statistical applications in biology, econometrics, and engineering.

John R Singler, Professor
PHD Virginia Polytechnic Institute
Computational methods for reduced order modeling, control and sensitivity analysis of partial differential equations, numerical analysis, applied mathematics, fluid dynamics.

Xuerong (Meggie) Wen, Associate Professor
PHD University of Minnesota
Nonlinear and nonparametric regression, regression graphics, computational statistics and statistical genetics, with an emphasis on sufficient dimension reduction in the context of regression.

Yanzhi Zhang, Associate Professor
PHD National University of Singapore
Multiscale modeling and simulations in material science, optimal control problems in superconductivity and superfluidity, Bose-Einstein condensation, quantized vortex dynamics, numerical algorithms for partial differential equations.

MATH 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

MATH 5001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

MATH 5010 Graduate Seminar (SEM 1.0)
Discussion of advanced or current topics.

MATH 5040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

MATH 5099 Graduate Research (IND 0.0-6.0)
Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

MATH 5105 Modern Algebra I (LEC 3.0)
Equivalence relations and functions, basic properties of groups, subgroups, permutations, cosets and Lagrange's Theorem, homomorphisms and isomorphisms, factor groups. Prerequisite: Math 3109 or graduate standing; preceded or accompanied by Math 3108.

MATH 5106 Modern Algebra II (LEC 3.0)
This course is a continuation of Math 5105. Rings and fields are discussed. Euclidean domains, principal ideal domains, unique factorization domains, vector spaces, finite fields and field extensions are studied. Prerequisite: Math 5105.

MATH 5107 Combinatorics And Graph Theory (LEC 3.0)
Covers some basics of enumeration and graph theory. Topics are selected from the following: permutations combinations, the inclusion/ exclusion principle, generating functions, recurrence relations, trees, networks, graph connectivity and graph coloring. Prerequisite: Comp Sci 1200 or Math 3109.

MATH 5108 Linear Algebra II (LEC 3.0)
Eigenvalue problems, Cayley-Hamilton theorem, Jordan normal form, linear functionals, bilinear forms, quadratic forms, orthogonal and unitary transformations, selected applications of linear algebra. Prerequisite: Math 3108.

MATH 5154 Mathematical Logic I (LEC 3.0)
A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Eng 5803, Comp Sci 5203 and Philos 4354).

MATH 5215 Introduction To Real Analysis (LEC 3.0)
Riemann-Stieltjes integration, sequences and series of functions, uniform approximation, the Banach Space C(a,b), Lebesgue measure and integration, the space LP(a,b), Fourier series. Prerequisite: Math 4209.

MATH 5222 Vector And Tensor Analysis (LEC 3.0)
Vector algebra, vector differential and integral calculus, line and surface integrals, theorems of Stokes and Gauss, tensor algebra and tensor analysis, applications to problems in kinematics, elasticity theory, fluid mechanics, electromagnetic theory, relativity theory. Prerequisite: Math 2222; Math 3103 or Math 3108.

MATH 5302 Intermediate Differential Equations (LEC 3.0)
Linear differential equations, vector-matrix systems, existence and uniqueness theory, nonlinear systems, phase-plane analysis, introduction to stability theory. Prerequisite: Math 3304 or Math 3329.

MATH 5325 Partial Differential Equations (LEC 3.0)
Linear equations, heat equation, eigenfunction expansions, Green's formula, inhomogeneous problems, Fourier series, wave equation. Prerequisite: Math 3304 with a grade of "C" or better.

MATH 5351 Introduction To Complex Variables (LEC 3.0)
The basic tools of complex variables are studied. These include the Cauchy-Riemann equations, complex contour integration, the Cauchy-Goursat theorem, conformal mappings, the calculus of residues and applications to boundary value problems. Prerequisite: Math 3304.

MATH 5483 Operational Calculus (LEC 3.0)
The Laplace transformation, properties of the transformation, various applications to ordinary and partial differential equations, systems with step and Dirac functions as driving forces, various non-elementary functions and their transforms, problems in heat conduction and wave motion, Fourier transforms and their operational properties. Prerequisite: Math 3304.

MATH 5512 Introduction To Differential Geometry (LEC 3.0)
Elements of the geometry of curves and surfaces in Euclidean three-space using methods of advanced calculus and vectors. Prerequisite: Math 4209 or Math 5222.

MATH 5530 Topics in Geometry - Graduate Option (LEC 3.0)
A survey of non-Euclidean geometries, finite geometries, affine and projective planes, metric postulates for the Euclidean plane, and selected topics. Students will demonstrate graduate-level mastery of the subject matter. Credit will not be given for both Math 4530 and Math 5530. Prerequisites: MATH 3108.

MATH 5585 Introduction To Topology (LEC 3.0)
Metric spaces; general topological spaces; connectedness, compactness, separation properties, functions and continuity. Prerequisite: Math 4209.

MATH 5601 Introduction to Numerical Analysis (LEC 3.0)
Mathematical foundation and theory of the basic numerical methods for nonlinear equations, function approximations, numerical differentiation/ integration, ordinary differential equations, and matrix computation, including convergence, accuracy, and stability analysis; extension of the basic methods to the corresponding more advanced methods. Prerequisites: Math 3304.

MATH 5602 Mathematical Foundation of Finite Element Methods (LEC 3.0)
Implementation and theoretical analysis of the finite element method for the approximate solution of partial differential equations. Implementation of finite element methods for elliptic and parabolic equations. Theoretical analysis of convergence, accuracy, and stability of approximate solutions. Prerequisites: Math 5601, or any instructor approved 4000-level or higher course from another discipline with a significant computational component.

MATH 5603 Methods of Applied Mathematics (LEC 3.0)
Methods to develop and analyze mathematical models. Topics include dimensional analysis and scaling, perturbation methods, and the construction of ordinary and partial differential equation models. Prerequisites: Math 3304 or 3329 with a grade of "C" or better, programming competency.

MATH 5604 Introduction to Numerical Methods for Differential Equations (LEC 3.0)
An introduction to finite difference methods for ordinary and partial differential equations, including (1) the derivation of the numerical methods, (2) implementation of the methods in Matlab, and (3) the mathematical accuracy and stability analysis of the methods. Prerequisites: MATH 3304 and programming competency (preferably Matlab).

MATH 5737 Financial Mathematics (LEC 3.0)
The course objective is to provide an understanding of the fundamental concepts of financial mathematics. Topics include pricing, assets-liability management, capital budgeting, valuing cash flow, bonds, futures, swaps, options. Preparation for the financial mathematics actuarial exam will be provided. Prerequisites: Math 1215 or Math 1221, Econ 1100 or Econ 1200, and one of the following: Stat 3111, Stat 3113, Stat 3115, Stat 3117 or Stat 5643. (Co-listed with Econ 5337).

MATH 5940 Mathematical Analysis For Secondary Teachers (LEC 3.0)
Designed to help teachers gain a deeper understanding of the fundamental idea in analysis, that of a limit. A discovery method is used which includes both individual and group work. Students will present their results in written and oral format. Prerequisite: Math 2222 or equivalent.

MATH 5948 Mathematical Analysis For Secondary Teachers Practicum (LEC 1.0)
An instructional unit based on the discovery method used in Math 340 will be designed by each student. These units will be class tested. The unit and results of class testing will be presented both in written and oral format. Prerequisite: Math 5940.

MATH 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

MATH 6001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

MATH 6010 Graduate Seminar (RSD 1.0-3.0)
Discussion of topics of current interest. Prerequisite: Graduate standing.

MATH 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

MATH 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

MATH 6099 Research (IND 0.0-15)
Investigation of an advanced nature leading to the preparation of a thesis or dissertation.

MATH 6105 Finite Fields And Applications (LEC 3.0)
After reviewing basic group theory and introducing basic properties of commutative rings, the main focus of the course will be on topics such as structure of finite fields, polynomials over finite fields, and applications such as coding theory and cryptography. Prerequisite: Math 5105.

MATH 6106 Introduction to Ring Theory (LEC 3.0)
Properties of rings with an emphasis on commutative rings. Ideals, factor rings, ring homomorphisms, polynomial rings; factorization, divisibility, and irreducibility. Introduction to extension fields and Galois theory. Applications may be chosen based on the interests of the students. Prerequisite: Math 5105.

MATH 6107 Group Theory (LEC 3.0)
Groups, subgroups, and factor groups; homomorphisms, isomorphisms, and associated theorems; abelian groups; Sylow theorems and p-groups; permutation groups; free groups and generators; representation theory; cohomology theory. Prerequisite: Math 5106.

MATH 6108 Applied Matrix Theory (LEC 3.0)
A second course in matrix theory directed toward applications. Linear spaces, linear operators, equivalence and similarity, spectral theorem, canonical forms, congruence, inertia theorem, quadratic forms, singular value decomposition and other factorizations, generalized inverses. Applications to optimization, differential equations, stability. Prerequisites: Math 3103, 3108, or 5302.

MATH 6215 Functions Of A Real Variable I (LEC 3.0)
Measure spaces, extensions of measures, probability spaces, measures and distributions in normed linear spaces, product measures, independence, integral and expectation, convergence theorems, Radon-Nikodyn theorem and applications. Lp spaces, selected topics. Prerequisite: Math 5215.

MATH 6216 Functions Of A Real Variable II (LEC 3.0)
Abstract measures and integrals, the Daniell integration theory, integration on locally compact Hausdorff spaces, integration in function spaces, selected topics. Prerequisite: Must be preceded by Math 6215.

MATH 6330 Theory Of Differential Equations I (LEC 3.0)
Stability theory, Liapunov's direct method, periodic solutions, Poincare-Bendixson theory, applications. Prerequisite: Math 5302.

MATH 6331 Theory Of Differential Equations II (LEC 3.0)
Continuation of Math 6330. Nonlinear oscillations, solutions near singular points, asymptotic methods, differential equations on manifolds, boundary-value problems. Prerequisite: Math 5302.

MATH 6351 Functions Of A Complex Variable I (LEC 3.0)
Complex plane, complex function theory, elementary Riemann surfaces, conformal mapping, complex integration, infinite complex series and sequences, calculus of residues with applications. Prerequisite: Math 4211.

MATH 6352 Functions Of A Complex Variable II (LEC 3.0)
Argument principle and consequences; harmonic functions and Dirichlet's problem; infinite products; entire, meromorphic and rational functions; analytic continuation; symmetry principle; conformal mapping; functions of several complex variables. Prerequisite: Preceded by Math 6351.

MATH 6375 Theory Of Partial Differential Equations (LEC 3.0)
Sobolev spaces; existence, uniqueness, and regularity of weak solutions to linear elliptic, parabolic, and hyperbolic PDEs; selected topics. Prerequisite: Math 6417.

MATH 6383 Special Functions (LEC 3.0)
Infinite products, gamma and beta functions, asymptotic series, the hypergeometric function, generalized hypergeometric functions, Bessel functions, generating functions; polynomials of legendre, Hermite, Laguerre, and Jacobi; elliptic functions, theta functions, Jacobian elliptic functions. Prerequisites: Math 4209 and 5351.

MATH 6417 Functional Analysis I (LEC 3.0)
Banach spaces, Hilbert spaces, linear transformations, Hahn-Banach theorem, duality, uniform boundedness principle, weak topologies, convexity, bounded linear maps, compact operators, and spectral theory. Prerequisites: Math 5215; Math 5108 or Math 5585.

MATH 6418 Functional Analysis II (LEC 3.0)
A continuation of Math 6417 with additional topics related to bounded and unbounded operators and their applications. Prerequisites: Math 6215 and Math 6417.

MATH 6461 Harmonic Analysis I (LEC 3.0)
Fourier series, norm and pointwise convergence of Fourier series, the conjugate and maximal functions, analytic functions in the unit disk and Hardy spaces, interpolation of linear operators and the Hausdorff-Young-Riesz Theorem, Sidon sets. Prerequisites: Math 5215 and Math 5351.

MATH 6462 Harmonic Analysis II (LEC 3.0)
Fourier integrals, almost-periodic functions on the real line, Banach algebras, Wiener's Tauberian Theorem and the prime number theorem, the Paley-Wiener Theorems, band-limited functions and Shannon's Theorem, the continuous wavelet transform, discrete wavelet transforms and frames, orthonormal bases of wavelets and multi-resolution analysis. Prerequisite: Must be preceded by Math 6461.

MATH 6540 Geometric Structures (LEC 3.0)
Selected topics in non-Euclidean, solid, projective, and fractal geometry. Prerequisite: Math 4530.

MATH 6548 Geometric Structures Practicum (LEC 1.0)
An instructional unit based on material learned in Math 6540 will be designed by each student. These units will be class tested. The unit and results of class testing will be presented both in written and oral format. Prerequisite: Math 6540.

MATH 6585 Topology I (LEC 3.0)
Topological spaces, uniform and quasi-uniform spaces, product and quotient spaces, separation properties and connected spaces, compactness. Prerequisite: Math 5585.

MATH 6586 Topology II (LEC 3.0)
Metrizability conditions, the theory of convergence using both filters and nets, completions and compactifications, and papers from the recent literature. Prerequisite: Math 6585.

MATH 6601 Numerical Analysis (LEC 3.0)
A proof based course emphasizing theoretical analysis of convergence and accuracy of various numerical methods including approximate solutions of linear and nonlinear equations, numerical integration, and function approximation, with implementation to validate results and illustrate the methods. Prerequisites: Any 4000 or higher level MATH course, or any instructor approved 4000 or higher level course from another discipline with a significant computational component.

MATH 6603 Mathematical Foundations of Finite Element Methods II (LEC 3.0)
Finite element methods for systems of partial differential equations and nonlinear partial differential equations. Mathematical theory for mixed finite elements, non-conforming finite elements, finite element interpolation, and finite element projections. Prerequisites: Math 5325 or Math 6601 or Math 6602.

MATH 6665 Mathematical Programming (LEC 3.0)
Linear optimization and its engineering applications; problem modeling, search-based optimization, the simplex method for solving linear problems, multi-objective optimization, discrete dynamic programming. Applications of optimization in the fields such as transportation, project management, manufacturing and facility location will be discussed. Prerequisites: One of the following:Stat 3113, Stat 3115, or Stat 3117; Math 3108. (Co-listed with Eng Mgt 6412 and Sys Eng 6412).

MATH 6737 Financial Mathematics II (LEC 3.0)
Continuation of Math 5737/Econ 5337. Topics include martingales and measures, stopping times, discrete and continuous time finance, Brownian motion, Ito calculus, stochastic differential equations, Black-Scholes-Merton formula, numerical procedures. Prerequisite: Math 5737 or Econ 5337. (Co-listed with Econ 6337).

MATH 6802 Mathematical Physics I (LEC 3.0)
Vector spaces, generalized coordinate transformations, vector analysis, tensors, partial differential equations in physics and boundary value problems, orthogonal functions and solutions to ordinary differential equations, hypergeometric, confluent hypergeometric, Legendre, Laguerre, and Bessel functions, Hermite polynomials, Green's functions in one dimension. (Co-listed with Physics 6403).

MATH 6803 Mathematical Physics II (LEC 3.0)
Green's functions in three dimensions, integral equations, complex variable theory and contour integration, group theory with applications to quantum mechanics, solid state and molecular physics. Prerequisite: Math 6802 or Physics 6403. (Co-listed with Physics 6413).

STAT 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

STAT 5001 Special Topics (IND 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

STAT 5099 Graduate Research (IND 0.0-6.0)
Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

STAT 5260 Statistical Data Analysis Using SAS (LAB 1.0 and LEC 2.0)
This course will introduce the student to selected data analytic tools implemented in the Statistical Analysis System (SAS) and appropriate and effective use of these tools. Focus would be on both the use of SAS data analytic tools and the theoretical and methodological rationale that form the basis of such analyses. Prerequisite: One of Stat 3113 or 3115 or 3117 or 5643; and one of Stat 5346 or 5353 or 6841 or 6343 or 6344 or 6545.

STAT 5346 Regression Analysis (LEC 3.0)
Simple linear regression, multiple regression, regression diagnostics, multicollinearity, measures of influence and leverage, model selection techniques, polynomial models, regression with autocorrelated errors, introduction to non-linear regression. Prerequisites: Math 2222 and one of Stat 3111, 3113, 3115, 3117, or 5643. (Co-listed with Comp Sci 5204).

STAT 5353 Statistical Data Analysis (LEC 3.0)
Introduction to methods for analyzing statistical data from experiments and Introduction to methods for analyzing statistical data from experiments and surveys. Analysis of variance, correlation, introduction to regression techniques, contingency tables, non-parametric techniques and introduction to modern statistical software. Prerequisites: Math 2222 and one of Stat 1115, 3113, 3115 and 3117.

STAT 5425H Introduction to Biostatistics-Honors (LAB 1.0 and LEC 3.0)

STAT 5643 Probability And Statistics (LEC 3.0)
Introduction to the theory of probability and its applications, sample spaces, random variables, binomial, Poisson, normal distributions, derived distributions, and moment generating functions. Prerequisite: Math 2222.

STAT 5644 Mathematical Statistics (LEC 3.0)
A continuation of Stat 5643 with introduction to the theories of point estimation, hypothesis testing, and interval estimation. Includes sufficiency, completeness, likelihood and how they apply to the exponential family. Prerequisite: Stat 5643.

STAT 5755 Statistical Models in Actuarial Science (LEC 3.0)
This course covers the statistical foundation of actuarial models and their applications. Topics include survival and severity models, Kaplan-Meier and Nelson-Aalen estimators, aggregate and credibility models for insurance losses, discrete time Markov chains, ruin theory, and simulation. Prerequisite: Stat 5643 and either Stat 5644 or a 3000-level Stat course. (Co-listed with Econ 4350).

STAT 5756 Statistical Models for Life Contingencies (LEC 3.0)
The basic statistical theory of actuarial models for life uncertainties such as time of death. Multiple life and multiple decrement models, statistical models for life and contingent insurance; last survivor, disability, withdrawal, retirement and reserving models for life insurance. Prerequisite: Stat 5643.

STAT 5756H Stat Models for Life Cont-Honors (LEC 3.0)

STAT 5814 Applied Time Series Analysis (LEC 3.0)
Introduction to time series modeling of empirical data observed over time. Topics include stationary processes, autocovariance functions, moving average, autoregressive, ARIMA, and GARCH models, spectral analysis, confidence intervals, forecasting, and forecast error. Prerequisites: One of Stat 3113, 3115, 3117, 5643 and one of Math 3103, 3108, or 5108.

STAT 5904 Science Education and Quantitative Literacy for Middle School Teachers (LEC 3.0)
An integrated science-mathematics course for middle school teachers. Course covers selected science/mathematics topics/skills specified in Missouri standards for grades 5-7. Inquiry based methods of teaching these topics in an integrated manner will be emphasized. Prerequisite: Current enrollment in a Teacher Education Program or a full or part-time teacher in a K-12 school. (Co-listed with Physics 4625).

STAT 5905 Making Sense Of Data For Elementary School Teachers (LEC 3.0)
An activity based course that is intended to provide elementary school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint. Prerequisite: Graduate Standing.

STAT 5906 Making Sense Of Data For Middle School Teachers (LEC 3.0)
An activity based course that is intended to provide middle school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint.

STAT 5907 Making Sense Of Data For High School Teachers (LEC 3.0)
An activity based course that is intended to provide high school teachers with the skills necessary to implement the Probability & Statistics strand of the American Statistical Association of the National Council of Teachers of Mathematics (NCTM) joint.

STAT 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects in the department. Consent of instructor required.

STAT 6001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

STAT 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

STAT 6050 Continuous Registration (LEC 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

STAT 6099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

STAT 6238 Stochastic Optimization (LEC 3.0)
Introduction to stochastic modeling theory and application. Topics include probability theory, Markov processes, renewal theory, and queuing theory. Additional topics include stochastic dynamic programming and stochastic programming. Prerequisite: Eng Mgt 5412. (Co-listed with Eng Mgt 6414).

STAT 6239 Clustering Algorithms (LEC 3.0)
An introduction to cluster analysis and clustering algorithms rooted in computational intelligence, computer science and statistics. Clustering in sequential data, massive data and high dimensional data. Students will be evaluated by individual or group research projects and research presentations. Prerequisite: At least one graduate course in statistics, data mining, algorithms, computational intelligence, or neural networks, consistent with student's degree program. (Co-listed with Comp Eng 6330, Elec Eng 6830, Sys Eng 6214 and Comp Sci 6405).

STAT 6342 Categorical Data Analysis (LEC 3.0)
A graduate-level introduction to statistical methods for analyzing categorical data. The topics include: contingency tables, generalized linear models including logistic regression models, log-linear models, ordinal and nominal regression models, Poisson regression, etc. The course will involve practical applications of the ideas and their implementations. Prerequisites: Stat 5644 and one of Stat 5346, Stat 5353, Stat 6344, or Stat 6553.

STAT 6343 Nonparametric Statistical Methods (LEC 3.0)
A course covering distribution free statistical methods. Topics include: order statistics, tests of hypotheses for one-sample and two-sample problems, analyses of variance, goodness-of-fit tests, runs test, independence and regression problems, point and interval estimation, ARE. Prerequisite: Stat 5644.

STAT 6344 Design And Analysis Of Experiments (LEC 3.0)
Experimental designs and their statistical analysis. Includes completely randomized designs, complete and incomplete blocking designs, factorial and fractional factorial experiments, multiple comparisons, response surface analysis. Prerequisites: One of Stat 5353, Eng Mgt 5715 and one of Stat 3111, 3113, 3115, 3117, 5643; or Stat 5643 and one of Stat 3111, 3113, 3115, 3117.

STAT 6545 Multivariate Statistical Methods (LEC 3.0)
Analysis of data consisting of simultaneous measurements on many variables. Multivariate normal distribution, multivariate analysis of variance, canonical correlation, principal components, classification and clustering techniques. Prerequisites: Stat 5644 and Math 3108.

STAT 6553 Linear Statistical Models I (LEC 3.0)
Includes a development of the theory of the distribution of quadratic forms, and the estimation of parameters and testing hypotheses in linear statistical models. Prerequisites: Math 3108 and Stat 5643 and either Stat 5353 or 5644.

STAT 6554 Linear Statistical Models II (LEC 3.0)
Includes the theory of polynomial models, regression models, experimental design models, incomplete block models, nonlinear models, with emphasis on optimum properties of point and interval estimation and the power of tests. Prerequisite: Stat 6553.

STAT 6570 Theory Of Reliability (LEC 3.0)
Statistical analyses of life-testing distributions such as the Weibull, gamma, exponential, logistic, and normal. Reliability estimation, tolerance limits, censored sampling, and applications of Monte-Carlo simulation. Prerequisite: Stat 5644.

STAT 6657 Advanced Mathematical Statistics I (LEC 3.0)
The theory of estimation and hypothesis testing. Completeness and sufficience. Maximum likelihood, minimax, Bayesian and invariant procedures for testing. Sequential desision rules. Emphasis on estimation. Prerequisites: Stat 5644 and Math 5215.

STAT 6658 Advanced Mathematical Statistics II (LEC 3.0)
A continuation of Stat 6657 with the emphasis on hypothesis testing. Prerequisite: Stat 6657.

STAT 6814 Statistical Time Series Analysis (LEC 3.0)
A formal introduction to the fundamentals of statistical modeling and analysis of discrete time series. Topics include autoregressive and moving average processes, ARMA models, second order stationarity, vector processes, autocorrelation function, Fourier representation, estimationa nd prediction of time series. Prerequisites: Stat 5643 and Math 3103 or 3108.

STAT 6841 Stochastic Processes (LEC 3.0)
Development and application of Poisson and nonhomogeneous Poisson processes; renewal processes; Markov chains and processes including birth and death processes; and normal processes, including Brownian motion. Prerequisites: Stat 5643 and Math 3304 or 3329.

STAT 6846 Advanced Probability Theory (LEC 3.0)
Probability spaces, random variables, distribution functions, expectations, independence, convergence theorems, characteristic functions, moment generating functions, and central limit theorem. Prerequisites: Stat 5644 and Math 5215.
