**MA 108R INTERMEDIATE ALGEBRA.**

This course is remedial in nature and covers material commonly found in second year high school algebra. Specific topics to be discussed include numbers, fractions, algebraic expression, simplifying, factoring, laws of exponents, linear equations, simple graphs and polynomial algebra. This course is not available for degree credit toward a bachelor's degree. Credit not available on the basis of special examination. Prereq: One year of high school algebra. Recommended for students with a Math ACTE score of 17 or less, or consent of department.

**MA 109 COLLEGE ALGEBRA.**

Selected topics in algebra and analytic geometry. Develops manipulative algebraic skills required for successful calculus study. Includes brief review of basic algebra, quadratic formula, systems of linear equations, introduction to analytic geometry including conic sections and graphing. This course is not available for credit to persons who have received credit in any mathematics course of a higher number with the exceptions of MA 112, 123, 162, 199, 201 and 202. Credit not available on the basis of special examination. Prereq: Two years of high school algebra and a Math ACTE score of 18 or above, or MA 108R, or math placement test.

**MA 110 ANALYTIC GEOMETRY AND TRIGONOMETRY.**

This is a course specifically designed for students intending to enroll in a calculus sequence. Topics will include trigonometric functions, exponentials and logarithms, graphs, polar coordinates, conic sections and systems of equations. Students may not receive credit for MA 110 and either of MA 109 or MA 112. This course is not available for credit to students who have received credit in any higher numbered mathematics course except for MA 123, 162, 199, 201 or 202. Credit is not available by special examination. Lecture, three hours; recitation, two hours per week. Prereq: Two years of high school algebra and a Math ACTE score of 23 or above, or consent of department.

**MA 112 TRIGONOMETRY.**

A standard course. Includes trigonometric functions, identities, multiple analytic formulas, laws of sines and cosines and graphs of trigonometric functions. This course is not available to persons who have received credit for any mathematics course of a higher number with the exception of MA 113, 123, 131, 132 and 162. Credit not available by special examination. Prereq: Two years of high school algebra or MA 108R.

**MA 113 CALCULUS I.**

A course in one-variable calculus, including topics from analytic geometry. Derivatives and integrals of elementary functions (including the trigonometric functions) with applications. Lecture, three hours; recitation, two hours per week. Prereq: Math ACTE score of 26 or above, or MA 109 and MA 112, or consent of department.

**MA 114 CALCULUS II.**

A continuation of MA 113, primarily stressing techniques of integration. Lecture, three hours; recitation, two hours per week. Prereq: High school trigonometry or MA 112; and a grade of C or better in MA 113, MA 132, or MA 223.

**MA 123 ELEMENTARY CALCULUS AND ITS APPLICATIONS.**

An introduction to differential and integral calculus, with applications to business and the biological and physical sciences. Not open to students who have credit in MA 113. Prereq: Math ACTE score of 21 or above, or MA 109 or math placement test.

**MA 132 CALCULUS FOR THE LIFE SCIENCES.**

Introduction to integral calculus, integration of logarithmic and exponential functions. Applications to the life sciences including biochemical rates and reactions and radioactive decay. An introduction to biological models and their associated differential equations. Prereq: MA 123 or consent of instructor.

**MA 162 FINITE MATHEMATICS AND ITS APPLICATIONS.**

Finite mathematics with applications to business, biology, and the social sciences. Linear functions and inequalities, matrix algebra, linear programming, probability. Emphasis on setting up mathematical models from stated problems. Prereq: MA 109 or equivalent.

**MA 193 CALCULUS WORKSHOP I.**

Intensive group study and practice relevant to MA 113. Admission only by consent of instructor. Laboratory, two hours per week per credit. Offered on a pass-fail basis only. Coreq: MA 113.

**MA 194 CALCULUS WORKSHOP II.**

Intensive group study and practice relevant to MA 114. Admission only by consent of instructor. Laboratory, two hours per week per credit. Offered on a pass-fail basis only. Coreq: MA 114.

**MA 199 TOPICS IN MATHEMATICS.**

Topics in mathematics to acquaint students in non-technical fields with ideas and methods of mathematics. Topics vary from semester to semester at the discretion of the instructor.

**MA 201 MATHEMATICS FOR ELEMENTARY TEACHERS.**

Basic concepts of measurement, geometry, probability, and statistics. Recommended only for majors in early elementary and middle school education. Prereq: MA 109.

**MA 202 MATHEMATICAL PROBLEM SOLVING FOR ELEMENTARY TEACHERS.**

Development of mathematical problem solving skills. Students will solve problems from such areas as algebra, geometry, probability, number theory, and logic. Credit not available on the basis of special examination. Prereq: A grade of "C" or better in MA 201. Also recommended: a course in logic (e.g. PHI 120) or a course in calculus (e.g. MA 123).

**MA 213 CALCULUS III.**

MA 213 is a course in multivariate calculus. Topics include three-dimensional vectors calculus, partial derivatives, double and triple integrals, sequences, and infinite series. Lecture, three hours; recitation, two hours per week. Prereq: MA 114 or equivalent.

**MA 214 CALCULUS IV.**

MA 214 is a course in ordinary differential equations. Emphasis is on first and second order equations and applications. The course includes series solutions of second order equations and Laplace transform methods. Prereq: MA 213 or equivalent.

**MA 261 INTRODUCTION TO NUMBER THEORY.**

Topics from classical number theory, including discussions of mathematical induction, prime numbers, division algorithms, congruences, and quadratic reciprocity. Prereq: Consent of instructor.

**MA 310 MATHEMATICAL PROBLEM SOLVING FOR TEACHERS.**


**MA 320 INTRODUCTORY PROBABILITY.**

Set theory; fundamental concepts of probability, including conditional and marginal probability; random variables and probability distributions (discrete and continuous); expected values and moments; moment-generating and characteristic functions; random experiments; distributions of random variables and functions of random variables; limit theorems. Prereq: MA 213 or equivalent. (Same as STA 320.)

**MA 321 INTRODUCTION TO NUMERICAL METHODS.**


**MA 322 MATRIX ALGEBRA AND ITS APPLICATIONS.**


**MA 330 HISTORY OF MATHEMATICS.**

A survey of the development of mathematics. Topics may include: the Egyptians and Babylonians, mathematics of the Greek Classical Age, Euclid and the Alexandrian School, the Renaissance, Fermat and the beginning of calculus, the work of Newton and Leibnitz, nineteenth century geometry, analysis and set theory. Prereq: MA 114.

**MA 340 DISCRETE STRUCTURES IN COMPUTER SCIENCE.**

Topics include permutations, combinations and partitions; inclusion-exclusion principle; generating functions and recurrence relations; elementary algorithms concerning graphs and trees; generation of random combinatorial and graphical examples; Boolean algebra, Boolean functions, switching circuits and mathematical logic; introduction to algebraic coding theory. Prereq: CS 245 and CS 270. Restricted to computer science, electrical engineering, mathematics and mathematical sciences majors. Others by permission. (Same as CS 340.)

**MA 341 TOPICS IN GEOMETRY.**

Selected topics in geometry including Euclidean and some non-Euclidean geometries. Prereq: Consent of instructor.
MA 351 ELEMENTARY TOPOLOGY I.  
A beginning course, with particular emphasis on point-set topology in Euclidean spaces.  
Prereq: MA 213 or consent of instructor.

MA 352 ELEMENTARY TOPOLOGY II.  
A continuation of MA 351, to include a discussion of metric spaces, completeness, general topological spaces, compactness, connectedness.  
Prereq: MA 351 or consent of instructor.

MA 361 ELEMENTARY MODERN ALGEBRA I.  
A beginning course, with particular emphasis on groups and rings.  
Prereq: MA 322 or consent of instructor.

MA 362 ELEMENTARY MODERN ALGEBRA II.  
A continuation of MA 361 to include a discussion of fields and topics in linear algebra.  
Prereq: MA 361 or consent of instructor.

MA 375 COMMUNICATING MATHEMATICS.  
A course intended to provide understanding of an experience with contemporary mathematical communication in a modern instructional setting.  
Prereq: MA 214, MA 322, at least one of (MA 351, MA 361, MA 471), and consent of instructor.

MA 398, 399 INDEPENDENT WORK IN MATHEMATICS.  
Reading courses for upper division students of high standing.  
Prereq: Mathematics or mathematical sciences major and a standing of 3.0 in the department.

MA 415G GRAPH THEORY.  
Theory of linear undirected graphs, including definitions and basic concepts, trees, connectivity, traversability, factorization, planarity and matrices.  
In addition, algorithm for finding spanning trees, testing connectivity, finding Euler trails, finding a maximum matching in a bipartite graph, and testing planarity will be presented at appropriate times.  
Applications of algorithms to operations research, genetics and other areas.  
About 55 percent of the course will be on general theory of graphs, 30 percent on algorithms and 15 percent on applications of these algorithms.  
Prereq: CS 101 or equivalent.  
(Same as CS 415G.)

MA 416G PRINCIPLES OF OPERATIONS RESEARCH I.  
The course is an introduction to modern operations research and includes discussion of modeling, linear programming, dynamic programming, integer programming, scheduling and inventory problems, and network algorithms.  
Prereq: MA 213 or equivalent.  
(Same as CS 416G.)

MA 417G PRINCIPLES OF OPERATIONS RESEARCH II.  
A continuation of MA 416 with topics selected from stochastic models, decision making under uncertainty, inventory models with random demand, waiting time models and decision problems.  
Prereq: CS/MA 416G and MA/STA 320, or consent of instructor.  
(Same as STA 417G.)

MA 422 NUMERICAL SOLUTIONS OF EQUATIONS.  
Linear equations: Gaussian elimination, special linear systems, orthogonalization, eigenproblem, iterative methods.  
Nonlinear equations: solutions of equations in one variable, solutions of systems of nonlinear equations.  
Optimization.  
Prereq: CS/MA 321 and MA 322; or consent of instructor.  
(Same as CS 422.)

MA 432G METHODS OF APPLIED MATHEMATICS I.  
Partial differentiation, Jacobians, implicit function theorem, uniform convergence of series, line and surface integrals.  
Green’s and Stokes’ theorems.  
Prereq: MA 214 or equivalent.

MA 433G INTRODUCTION TO COMPLEX VARIABLES.  
Elementary complex variable theory with applications.  
Complex field, analytic functions, Cauchy theorem, power series, residue theory.  
Prereq: MA 214.

MA 471G ADVANCED CALCULUS I.  
A careful and vigorous investigation of the calculus of functions of a single variable.  
Topics will include elementary topological properties of the real line, convergence limits, continuity, differentiation and integration.  
Prereq: MA 214 and MA 322.

MA 472G ADVANCED CALCULUS II.  
A continuation of MA 471G to functions of several variables.  
A careful and rigorous investigation of the extensions of the concepts of the one variable calculus to n-dimensions.  
Prereq: MA 471G or consent of instructor.

MA 481G DIFFERENTIAL EQUATIONS I.  
Brief review of linear differential equations and matrix algebra, eigenvalues and eigenvectors of matrices, systems of linear differential equations with constant coefficients, applications, Sturm separation and comparison theorems, Sturm-Liouville theory for second-order equations and applications.  
Prereq: MA 214 and MA 322.

MA 483G DIFFERENTIAL EQUATIONS II.  
A continuation of MA 481G.  
Topics will include perturbation theory; power series techniques and regular singular point theory; asymptotics; eigenfunction expansions; qualitative behavior of linear and nonlinear differential equations.  
Prereq: MA 481G or equivalent.

MA 485G FOURIER SERIES AND BOUNDARY VALUE PROBLEMS.  
Orthogonal sets of functions, Fourier series and integrals, solution of boundary value problems, theory and application of Bessel functions and Legendre polynomials.  
Prereq: MA 432G or equivalent.  
(Same as EM 585.)

MA 501, 502 SEMINAR IN SELECTED TOPICS.  
Various topics from the basic graduate courses.  
Designed as a course for teachers of lower division mathematics and usually offered in connection with a summer institute.  
May be repeated to a maximum of six credits.  
Prereq: Teaching experience in the field of mathematics and consent of instructor.

MA 506 METHODS OF THEORETICAL PHYSICS I.  
The course and its sequel (MA/PHY 507) are designed to develop, for first-year graduate students, familiarity with the mathematical tools useful in physics.  
Topics include curvilinear coordinates, infinite series, integrating and solving differential equations of physics, and methods of complex variables.  
Work with Green’s functions, eigenvalues, matrices and the calculus of variations are included as a part of MA/PHY 506 and 507.  
Prereq: PHY 404G or equivalent.  
(Same as PHY 506.)

MA 507 METHODS OF THEORETICAL PHYSICS II.  
Continuation of MA/PHY 506.  
Fourier and Laplace Transforms, the special functions (Bessel, Elliptic, Gamma, etc.) are described.  
Work with Green’s functions, eigenvalues, matrices and the calculus of variations are included as a part of MA/PHY 506 and 507.  
Prereq: MA/PHY 506.  
(Same as PHY 507.)

MA 515 MATHEMATICAL PROGRAMMING AND EXTENSIONS.  
Mathematical and computational aspects of linear programming, large scale structures, quadratic programming, complementary pivoting, introduction to nonlinear programming.  
Applications to engineering and economics.  
Additional topics selected in geometric programming, stochastic programming.  
Prereq: A course in linear algebra or consent of instructor.  
(Same as OR/STA 515.)

MA 522 MATRIX THEORY AND NUMERICAL LINEAR ALGEBRA I.  
Review of basic linear algebra from a constructive and geometric point of view.  
Factorizations of Gauss, Cholesky and Gram-Schmidt.  
Determinants.  
Linear least squares problems.  
Rounding error analysis.  
Stable methods for updating matrix factorizations and for linear programming.  
Introduction to Hermitian eigenvalue problems and the singular value decomposition via the QR algorithm and the Lanczos process.  
Method of conjugate gradients.  
Prereq: MA 322.  
(Same as CS 522.)

MA 532 ORDINARY DIFFERENTIAL EQUATIONS.  
Successive approximations and elementary existence theorems for scalar and vector equations, qualitative behavior of solutions as functions of initial conditions and parameters, linear systems with constant and periodic coefficients, stability theorems for second order linear and nearly linear equations, second order boundary value problems and regular singular point theory.  
Prereq: MA 322 and either 432G or 471G.

MA 533 PARTIAL DIFFERENTIAL EQUATIONS.  
Elementary existence theorems, equations of first order, classification of linear second order equations, the Cauchy and Dirichlet problems, potential theory, the heat and wave equations, Green’s and Riemann functions, separation of variables, systems of equations.  
Prereq: MA 532 and MA 472G or equivalent.

MA 537 NUMERICAL ANALYSIS.  
Floating point arithmetic.  
Direct methods for the solution of systems of linear algebraic equations.  
Polynomial and piecewise polynomial approximation, orthogonal polynomials.  
Numerical integration.  
Newton-Cotes formulas and Gaussian quadrature.  
Basic methods for initial value problems for ordinary differential equations.  
The emphasis throughout is on the understanding and use of software packages for the solution of commonly occurring problems in science and engineering.  
Prereq: CS/MA 321 or equivalent or graduate standing or consent of instructor.  
Knowledge of a procedural computer language is required.  
(Same as CS/EGR 537.)
MA 538 NUMERICAL ANALYSIS II. (3)
A continuation of CS/MA 537. Roots of a nonlinear equation and minimization of a function of a single variable. Linear difference equations. Numerical methods for ordinary differential equations: initial value problems, and elementary techniques for two-point boundary value problems. Prereq: A grade of B or better in CS/MA 321 or CS/MA 537 or equivalent. (Same as CS 538.)

MA 551 TOPOLOGY I. (3)
Topological spaces, products, quotients, subspaces, connectedness, compactness, local compactness, separation axioms, convergence. Prereq: Consent of instructor.

MA 561 MODERN ALGEBRA I. (3)
Algebraic structures, quotient structures, substructures, product structures, groups, permutation groups, groups with operators, and the Jordan-Holder theorem. Prereq: Consent of instructor.

MA 565 LINEAR ALGEBRA. (3)
Review of finite dimensional linear algebra, the rank of a matrix, systems of linear equations, determinants, characteristic and minimal polynomials of a matrix, canonical forms for matrices, the simplicity of the ring of linear mappings of a finite dimensional vector space, the decomposition of a vector space relative to a group of linear mappings and selected topics of a more advanced nature. Prereq: MA 322 or consent of instructor.

MA 570 MULTIVARIATE CALCULUS. (3)
A self-contained course in n-dimensional analysis, including the general form of Stokes' theorem. Prereq: MA 432G or equivalent.

MA 571 ANALYSIS I. (3)
Sequences and series of real and complex numbers, sequences of functions. Riemann-Stieltjes integration, Lebesque measure and integration. Prereq: MA 471G or consent of instructor.

MA 611 INDEPENDENT WORK IN MATHEMATICS. (3-9)
Reading course for graduate students in mathematics. May be repeated to a maximum of nine credits. Prereq: Major in mathematics, a standing of at least 3.0 and consent of instructor.

MA 613 PROBLEMS SEMINAR IN OPERATIONS RESEARCH. (3)
In this course the student is exposed to the art of applying the tools of operations research to real world problems. The seminar is generally conducted by a group of faculty members from the various disciplines to which operations research is applicable. Prereq: MA 617 and STA 525 or consent of instructor. (Same as EE/STA/BA/OR 619.)

MA 615 CONVEX ANALYSIS AND OPTIMIZATION. (3)
Convex sets and convex functions. Separation and Helly-type theorems. Duality theory and minimax theorems. Algorithmic procedures for constrained and unconstrained problems. May be repeated to a maximum of six credits. Prereq: MA 472G or consent of instructor.

MA 616 NUMERICAL TECHNIQUES FOR NONLINEAR OPTIMIZATION. (3)
Unconstrained optimization, Kuhn-Tucker conditions for nonlinear programs (constrained optimization). Solutions procedures: methods of feasible directions, penalty methods, approach approximation methods, the method of generalized Lagrangians. Discrete optimal control (dynamicals formation). Solutions methods for control problems: decomposition and structured problems. Prereq: MA 515 or consent of instructor. (Same as OR 616.)

MA 617 MARKOVIAN DECISION PROBLEMS. (3)
Control of discrete-time Markov processes by dynamic programming inventory theory. Computational approaches to control of Markov chains. State space methods: modeling of engineering and economic systems by linear stochastic difference equations. The discrete-time matrix Riccati equation, Kalman filtering. Optimal control of linear stochastic difference equations with complete or incomplete state information and with quadratic cost criterion. Prereq: STA 624. (Same as OR 617.)

MA 618 COMBINATORICS AND NETWORKS. (3)
Graphs, networks, min max cut theorem and applications; transportation problems, shortest route algorithms, critical path analysis, multi-commodity networks, covering and packing problems; integer programming, branch-and-bounding techniques, cutting plane algorithms, computational complexity. Prereq: MA 515, may be taken concurrently with MA 515. (Same as OR 618.)

MA 622 MATRIX THEORY AND NUMERICAL LINEAR ALGEBRA II. (3)

MA 625 NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS. (3)
Numerical solution techniques for boundary value problems for ordinary differential equations, and for parabolic and elliptic partial differential equations. Prereq: CS/MA/EEGR 537 or consent of instructor.

MA 628 APPLIED MATHEMATICS IN THE NATURAL SCIENCES II. (3)
Continuation of MA/EM 527 with emphasis on special topics and techniques applied to partial differential equations that occur in various physical field theories. Field equations of continuum mechanics of solids and fluids are reviewed. The method of characteristics, elliptic functions and integrals, Legendre polynomials, Mathieu functions, integral equations and transforms, and the methods of potential theory are examples of selected topics studied in introductory applications. Intended for students in applied mathematics, science and engineering. Prereq: MA/EM 527. (Same as EM 628.)

MA 630 MATHEMATICAL FOUNDATIONS OF STOCHASTIC PROCESSES AND CONTROL THEORY I. (3)
A modern treatment of stochastic processes from the measure theoretic point of view with applications to control theory; the basic notions of probability theory, independence, conditional expectations, separable stochastic processes, martingales, Markov processes, second order stochastic processes. Prereq: MA 432G and 670.

MA 631 MATHEMATICAL FOUNDATIONS OF STOCHASTIC PROCESSES AND CONTROL THEORY II. (3)

MA 632 ADVANCED DIFFERENTIAL EQUATIONS. (3)
General existence and uniqueness theorems, linear systems, regular and singular eigenvalue problems, stability theory, nonlinear oscillation theory, asymptotic theory, equations with retarded argument. Prereq: MA 532 or consent of instructor.

MA 633 THEORY OF PARTIAL DIFFERENTIAL EQUATIONS. (3)
A continuation of MA 533. Topics may include hypoelliptic operators and interior regularity of solutions; (P)-convexity and existence theorems; regularity up to the boundary; applications of the maximum principle; semi-group theory for evolution equations; perturbation methods; well-posed and improperly posed problems; equations with analytic coefficients; a singularity behavior of solutions; nonlinear problems. Prereq: MA 533.

MA 639 RESEARCH PROJECTS IN BIOLOGICAL MODELING. (3)
Mathematical modeling of selected biological systems. Small groups will define the problem, develop a mathematical model, and examine its biological implications. Systems to be modeled may be chosen from any area of the life sciences depending on the experience and interest of the group members. The groups will be supervised by a faculty member from biological sciences and one from mathematics. Prereq: MA/BIO 411G or consent of instructor. (Same as BIO 639.)

MA 641, 642 DIFFERENTIAL GEOMETRY. (3 ea.)
Tensor products, exterior algebra, differentiable maps, manifolds, geodesics, metric properties of curves in Euclidean fundamental forms, surfaces. Prereq: Consent of instructor.

MA 651 TOPOLOGY II. (3)
Embedding and metrization, compact spaces, uniform spaces and function spaces. Prereq: MA 551.

MA 654 ALGEBRAIC TOPOLOGY I. (3)
Homotopy and homology theories, complexes and applications. Prereq: MA 551, 561, 651 or equivalent.

MA 655 ALGEBRAIC TOPOLOGY II. (3)
Singular homology theory and applications, homology of products, singular and Cech cohomology with applications. Prereq: MA 654.

MA 661 MODERN ALGEBRA II. (3)
Rings, fields of quotients, rings of polynomials, formal power series, modules, exact sequences, groups of homomorphisms, natural isomorphisms, algebras and tensor algebras. Prereq: MA 561 or consent of instructor.

MA 667 GROUP THEORY. (3)
A study of homomorphisms for groups, finite groups, solvable groups, nilpotent groups, free groups, and abelian groups. Prereq: MA 661.
### MA 760 ANALYSIS II.
Continuation of MA 571. Absolutely continuous functions on the real line, Lebesgue spaces, beginning theory of Banach spaces including the Hahn-Banach closed graph, and open mapping theorems. Prereq: MA 571 or consent of instructor.

### MA 671 FUNCTIONS OF A COMPLEX VARIABLE I.
Differentiation and integration, contour integration, poles and residues. Taylor and Laurent series, and conformal mapping. Prereq: MA 571, 670.

### MA 672 FUNCTIONS OF A COMPLEX VARIABLE II.
A continuation of MA 671 to include the Riemann Mapping theorem, Dirichlet problem, multiple valued functions, Riemann surfaces and applications. Prereq: MA 671.

### MA 673 SEVERAL COMPLEX VARIABLES.

### MA 678 MATHEMATICAL THEORY OF OPTIMAL CONTROL.
An introduction to classical calculus of variations. Optimality conditions for control problems, Pontryagin principle, Dynamic Programming, Applications to Aerospace and Economics. Prereq: Consent of instructor.

### MA 681 FUNCTIONAL ANALYSIS I.
General theory of normed linear spaces including the Hahn-Banach separation theorems, principle of uniform boundedness and closed graph theorem. Dual spaces and representation theorems for linear functionals. Abstract measure theory and Riesz representation theorem for (C(X). Prereq: MA 670 or consent of instructor.

### MA 682 FUNCTIONAL ANALYSIS II.

### MA 715 SELECTED TOPICS IN OPTIMIZATION.
Topics will be selected from the areas of mathematical control theory, integer programming, combinatorial optimization, large scale optimization, nonlinear programming, dynamic optimization, etc. May be repeated to a maximum of nine credits.

### MA 721 SELECTED TOPICS IN NUMERICAL ANALYSIS.
Review of current research in numerical analysis. May be repeated to a maximum of nine credits. Prereq: Consent of instructor.

### MA 722 SELECTED TOPICS IN DIFFERENTIAL AND INTEGRAL EQUATIONS.
Advanced topics in theory of differential (ordinary of partial) and integral equations such as topological dynamics, almost periodic solutions, stochastic differential equations, integro-differential and differential-difference equations, generalized functions as solutions, non-linear partial differential equations, singular integral equations.

### MA 748 MASTER’S THESIS RESEARCH.
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

### MA 749 DISSERTATION RESEARCH.
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

### MA 751, 752 SELECTED TOPICS IN TOPOLOGY.
Continuation of MA 571. Absolutely continuous functions on the real line, Lebesgue spaces, beginning theory of Banach spaces including the Hahn-Banach closed graph, and open mapping theorems. Prereq: MA 651.

### MA 761 HOMOLOGICAL ALGEBRA.
Homological algebra, modules, exact sequences, functors, homological dimension, extension problems. Prereq: Consent of instructor.

### MA 764, 765 SELECTED TOPICS IN ALGEBRA.
Reports and discussion on recent advances in group theory, ring theory, and homological algebra. Prereq: MA 661 and consent of instructor.

### MA 768 RESIDENCE CREDIT FOR THE MASTER’S DEGREE.
May be repeated to a maximum of 12 hours.

### MA 769 RESIDENCE CREDIT FOR THE DOCTOR’S DEGREE.
May be repeated indefinitely.

### MA 772 SELECTED TOPICS IN THE THEORY OF COMPLEX VARIABLES.
Prereq: Consent of instructor.

### MA 773 SELECTED TOPICS IN ANALYSIS.
May be repeated to a maximum of six credits. Prereq: Consent of instructor.

### MA 778 MATHEMATICAL SEMINAR.
May be repeated once to a total of six credits. Prereq: Consent of instructor.

## MB 
**Microbiology**

See courses listed under Biological Sciences.

## MD 
**Medicine (Special Topics)**

### MD 500 SPECIAL TOPICS COURSE.
Interdisciplinary, topical or experimental course, approved by the Dean of the College of Medicine; content variable, depending upon instructor(s). A particular topic can be offered no more than twice under the course number MD 500. May be repeated to a maximum of six credits. Prereq: Consent of instructor.

### MD 810 PHYSICIANS, PATIENTS AND SOCIETY.
In small groups, students will work with a preceptor to study twelve written clinical situations. Students will contemplate, investigate, comprehend, and discuss biological/clinical, psychological, social, economic, ethical, legal, and professional issues concerning the problem-based histories. Prereq: Admission to UK College of Medicine.

### MD 811 INTRODUCTION TO THE MEDICAL PROFESSION.
The Introduction to the Medical Profession course will combine small group meetings, lecture, and practical experience in providing students with the basic skills necessary to successfully engage in clinical rotations. First year medical students will participate in four segments: observation period, interviewing and communication skills, physical examination and physical diagnosis, and clinical decision making sessions. Prereq: Admission to UK College of Medicine.

### MD 831 INTEGRATIVE COLLOQUIUM.
(2-4)
This course will allow junior medical students, using the problem based learning approach, to explore medical cases that have multidimensional aspects involving not only the patient’s disease but issues of ethics, societal problems, familial considerations, and economic issues which are relevant to the development of the truly complete physician. A series of approximately 7-8 problem cases will be presented in small groups with faculty mentors. They will study various aspects of a patient’s condition allowing for consideration of family, community, physician and societal responsibilities. When possible, the students will be joined by patients with the problem being discussed. Issues may include situations involving alcoholism and substance abuse, AIDS, brain death and organ procurement. Medical problems which often have these associated issues will be used as the presenting problem. Laboratory, 40 hours per week per credit. Prereq: Promotion to third year medical school.

### *MD 832 CLINICAL NEUROSCIENCES/NEUROLOGY.
(4)
This course provides opportunity for third year medical students to recognize, treat, and understand the etiology and pathology of common neurologic disorders and emergencies. Laboratory, forty hours per week. Prereq: Admission to third year of medical curriculum.

### #MD 833 CLINICAL NEUROSCIENCES/PSYCHIATRY.
(4)
This course provides opportunity for third year medical students to recognize, treat, and understand the etiology and pathology of common psychiatric disorders and emergencies. Laboratory, forty hours per week. Prereq: Admission to third year of medical curriculum.

### MD 850 INTEGRATIVE STUDIES.
(4)
This course is provided for senior medical students who are interns in the internal medicine residency program. The course focuses on the study of scientific, psychosocial, ethical, economic, preventive, political, legal, health policy, etc., aspects of contemporary medical practice. It is tutorial in form, involves problem-based-learning and the study of detailed, complex medical case histories. In interpreting these cases, students draw on the medical and scientific literature, computer data bases, the premedical and medical faculty, and on the expertise of nurses, hospital administrators, ethicists, and other University and community scholars and practitioners. Prereq: Three years of Medical School.
ME 007, 008 THE ENGINEERING PROFESSION (Senior). (0)
Lectures on professional growth, conduct and ethics. Activities of the student branches of the corresponding professional societies. May be repeated.

ME 101 ORIENTATION TO MECHANICAL ENGINEERING (Freshman and Transfer Students). (1)
Introduction to the profession of mechanical engineering: its history, practice, and methods of analysis.

ME 105 BASIC ENGINEERING GRAPHICS. (2)
Basic Engineering Graphics involves the use of basic engineering drawing equipment with freehand sketching and use of a micro-computer graphics workstation in the study of orthographic projection, auxiliary view projection, section views, pictorial drawing, with introduction to dimensioning and tolerancing. Class, six hours.

ME 151 MANUFACTURING ENGINEERING. (3)
A background course in the area of manufacturing processes and systems. Includes a study of machining operations, foundry mechanization, forging, sheet metal work, powder metal products, production molding and production machines and processes.

ME 220 ENGINEERING THERMODYNAMICS I. (3)
Fundamental principles of thermodynamics. Prereq: PHY 231. Prereq or concur: MA 214.

ME 301 ENGINEERING EXPERIMENTATION I. (3)
An instrumentation laboratory to provide the student with an understanding of the characteristics and application of instrumentation related to basic measurements in mechanical engineering. Design and planning of experiments. Uncertainty analysis. Principles and application of technical writing and information retrieval. Lecture, two hours, laboratory, two hours. Prereq: Engineering standing, CS 221 and ME 330.

ME 311 ENGINEERING EXPERIMENTATION II. (3)
A laboratory to instruct the student in the performance of basic mechanical engineering components and systems. Performance of experiments, application of theory and reporting. Introduction to experimentation. Introduction to error analysis. Lecture, one hour; laboratory, four hours. Prereq: ME 310, 321, 325 and engineering standing.

ME 321 ENGINEERING THERMODYNAMICS II. (3)

ME 325 ELEMENTS OF HEAT TRANSFER. (3)

ME 330 FLUID MECHANICS. (3)
Introduction to the physical properties of fluids, fluid statics. Equations of conservation of mass, momentum and energy for systems and control volumes. Dimensional analysis and similarity. Principles of inviscid and real fluid flows; flow through pipes and around bodies. Application and design of fluid handling systems. Prereq: ME 220 or CME 210, CS 221, MA 214, and engineering standing.

ME 340 INTRODUCTION TO MECHANICAL SYSTEMS. (3)
Modeling of mechanical, thermal, hydraulic and other phenomena from a systems viewpoint. Analysis of continuous-time models for free and forced response. Laplace transforms, transfer functions and block diagrams. Introduction to numerical simulation. Analysis of higher-order systems. Prereq: EM 313, CS 221, engineering standing.

ME 344 MECHANICAL DESIGN. (3)
Fundamentals of design with methods of approximation. Introduction to optimum design considerations. Synthesis and problems on the design of various mechanical elements. Prereq: ME 151, EM 302, engineering standing; concur: EM 313.

ME 346 MECHANICAL SYSTEMS DESIGN. (3)
A course using a modified case method to teach the principles involved in designing complete mechanical systems. A unique problem is chosen each semester. The system to be designed is usually one not presently in existence, but for which a need exists. The student is required to synthesize a general solution to a problem, apply analytical techniques to arrive at a more detailed solution, and finally prepare a report presenting by freehand sketches and written descriptions his solution to the problem. Lecture, one hour; laboratory, six hours. Prereq: ME 344 and engineering standing.

ME 347 DYNAMIC ANALYSIS OF DESIGN PROBLEMS. (3)
A course emphasizing the role of analysis in design. Actual design objectives are met through the use of mathematical modeling techniques and the application of the principles of dynamics, kinematics and vibrations. Prereq: EM 313, engineering standing; concur: ME 344.

ME 358 ECONOMIC ANALYSIS OF MECHANICAL SYSTEMS. (3)
Formulation of economic relationships. Familiarization with alternative mechanical systems and application of economic principles of selection of alternates. Prereq: ME 321, engineering standing or consent of instructor.

ME 366 THERMAL POWER SYSTEMS. (3)
Application of basic thermodynamics, fluid mechanics and heat transfer to the analysis of thermal systems. Internal and external combustion power plant systems and noncombustion thermal systems are analyzed. Commercial aspects of thermal systems are studied. Prereq: ME 321 and Engineering standing.

ME 371 SEMINAR. (1)
Students will undertake literature searches on a major engineering problem and will report orally on these findings approximately once a week. A written summary of these presentations will be submitted at the end of the semester. Lecture, two hours per week. Prereq: Engineering standing.

ME 380 TOPICS IN MECHANICAL ENGINEERING (Variable topics). (3)
A lecture-recitation course on a topic of current interest. Modern developments in mechanical engineering will be stressed. Offered as a technical elective in mechanical engineering. May be repeated to a maximum of nine credits. Prereq: Variable, given when topic identified and engineering standing.

ME 385 INDEPENDENT WORK IN MECHANICAL ENGINEERING. (1-6)
Special research and problems for individual students who wish to pursue independent investigations. May be repeated to a maximum of six credits. Prereq: Consent of department chairperson via permit.

ME 407 ENGINEERING ETHICS. (1)
Review of the growth and development of the profession, engineering ethics, obligations to employers and peers, limits of professional responsibility, codes of ethics and enforcement, and case studies.

ME 408 SAFETY ENGINEERING. (2)
Review of general safety hazards, system engineering safety, fault free analysis, reliability, accident reconstruction and investigation. Case studies will be included. Concur: ME 344.

ME 412 SENIOR DESIGN PROJECT. (3)
A project concerned with the design of a complex system of current interest to mechanical engineers. Students will work in small groups and emphasis will be on original work. Lecture, one hour; laboratory, four hours per week. Prereq: ME 325, ME 347, ME 440, and Engineering standing.

ME 440 DESIGN OF CONTROL SYSTEMS. (3)
Fundamentals of automatic control theory and design; feedback control systems; transducers, detectors and actuators; types of controllers. Control system design using root-locus, Nyquist and Bode methods; compensation. Introduction to modern control theory, nonlinearities and digital control. Prereq: ME 340 and ME 101.

ME 475G INTRODUCTION TO NUCLEAR ENGINEERING. (3)

ME 480G HEATING, VENTILATING AND AIR-CONDITIONING. (3)
An introductory course emphasizing the engineering systems aspects of thermal environmental design. Principles and applications of building energy requirements and thermal comfort criteria. Prereq: ME 325 and Engineering standing or consent of instructor. (Same as AEN 480G.)

ME 501 MECHANICAL DESIGN WITH FINITE ELEMENT METHODS. (3)
Mechanical design techniques based on the finite element method, using machine design background as the starting point. Techniques for modeling machine elements will be shown in relation to the basic FEM theory. Emphasis will be on quantifying loads, the resulting stress and deflection, and relating them to design allowances, leading to an acceptable design solution. Prereq or concur: ME 344.
ME 505 MODELING OF MANUFACTURING PROCESSES AND MACHINES. (3)
A study of the major manufacturing processes and equipment. Emphasis on mathematic¬
cal and computer models of these processes, as used in automated manufacturing and control of these processes. Lecture, two hours; laboratory, two hours. (Same as MFS 505.)

ME 506 COMPUTER-AIDED GRAPHICS AND DESIGN. (3)
Development of computer graphics and interactive graphics methods and applications to problem solving and design practices. Emphasis on graphics principles, data management, interactive programming, and integrated analysis/design. Prereq: ME 344 and CS 221.

#ME 507 DESIGN FOR MANUFACTURING. (3)
The topics will include fundamentals of concurrent engineering, product life cycle, product specification, standardization, functional requirements and datum features, selection of materials and manufacturing processes, cost analysis, case studies on designing for quality, economy, manufacturability and productivity. Prereq: ME 344 and engineering standing. (Same as MFS 507.)

ME 510 DYNAMICS AND DESIGN OF ROBOT MANIPULATORS. (3)
Analysis of the design and operation of robotic systems. Emphasis on robot kinematics, dynamics, differential motion, manipulator Jacobian, motion trajectories, geometric modeling, force and vibration analyses. Various practical applications and real cases are investigated. Prereq: ME 340 or both EE 420G and EM 230. (Same as EM 510.)

#ME 512 MANUFACTURING SYSTEMS. (3)
This course introduces students to fundamentals of design, planning and control of manufacturing systems aided by computers. Concepts of control hardware, NC programming languages, software aspects related to NC manufacturing, programmable controllers, performance modeling of automated manufacturing systems, group technology and flexible manufacturing systems, etc. will be addressed. Prereq: Engineering standing. (Same as MFS 512.)

ME 514 NUCLEAR REACTOR ANALYSIS AND FUEL MANAGEMENT. (3)
Analysis of the fission process and cross section relationships. Homogeneous reactor theory. Reflected reactor multigroup methods. Design of heterogeneous reactors, including fuel considerations, burnup calculations, source terms and storage considerations. Elementary kinetic considerations are included. Prereq or concur: MA 432G.

ME 529 APPLIED FLUID MECHANICS. (3)
Continuation of ME 330. Problem solving for ideal and viscous flows for design and research oriented purposes. Development and application of basic equations to engineering problems with emphasis on numerical modeling using computers. Prereq: ME 330 or CE 341, CS 221, engineering standing. (Same as CE 542.)

ME 530 GAS DYNAMICS. (3)
Consideration of the mass, energy and force balances applied to compressible fluids. Isentropic flow, diabatic flow, flow with friction, wave phenomena and one-dimensional gas dynamics. Applications to duct flows and to jet and rocket propulsion engines. Prereq: ME 321, ME 330 and Engineering standing.

ME 531 FLUID DYNAMICS I. (3)
Stress at a point (introduced as a tensor of rank two). Equation of conservation of mass, rate of strain tensor, derivation of Navier-Stokes equation, source-sink flows, motion due to a doublet, vortex flow, two- and three-dimensional rotational flow due to a moving cylinder with circulation, two-dimensional airfoils. Prereq: ME 330, MA 432G and Engineering standing.

ME 542 KINEMATIC SYNTHESIS OF MECHANISMS. (3)
Fundamentals in the analysis and synthesis of mechanisms including coupler curves, guided plane systems and linkage design. Prereq: ME 344, EM 313 and Engineering standing.

ME 550 APPLICATIONS OF HEAT TRANSFER. (3)
The three basic modes of heat transfer, i.e., conduction, convection, and radiation, are treated in depth with the emphasis on fundamentals, analyses, and practical engineering applications. Several computer codes developed for heat transfer problems will be used to study multimode heat transfer problems. This course is a dual level course, intended basically for mechanical engineering undergraduate students. Credit will not be given for this course to a student who has credit in ME 625, ME 626 or ME 627. Prereq: ME 325, Engineering standing.

ME 560 ENGINEERING OPTICS. (3)
Fundamentals of geometrical and physical optics; applications as related to problems in engineering design and research; details of some optical measurement techniques; introduction to lasers and their applications to heat transfer and combustion research; inverse analytical techniques for determining optical properties of small particles from light scattering and extinction measurements. Prereq: Engineering standing.

ME 563 BASIC COMBUSTION PHENOMENA. (3)
Simultaneous application of fluid mechanics, heat and mass transfer, chemical kinetics and thermodynamics to combustion. Topics covered include chemical kinetics, chain and thermal explosions, detonation and deflagration, flammability limits, stirred reactors. Flame stabilization in high and low velocity streams, laminar and turbulent diffusion flames, droplet burning, and metal combustion. Prereq: ME 330 and Engineering standing; prereq or concur: ME 325.

ME 564 PROPULSION SYSTEM DESIGN. (3)
Design of systems for aircraft or missile propulsion. Centrifugal compressors, axial-flow compressors, turbine and exhaust systems, and combustion chambers. Lecture, two hours; laboratory, two hours. Prereq: ME 530 and Engineering standing.

ME 566 DIRECT ENERGY CONVERSION PROCESSES. (3)
Basic consideration of direct conversion of thermal and chemical energy to electrical energy. Analysis and design of thermoelectric, thermionic, photovoltaic, magnetohydrodynamic and electrochemical systems. Prereq: ME 325 and Engineering standing.

ME 583 BIOTECHNOLOGY. (3)
The human body as a mechanical system responding to sustained and transient forces and pressures, such as occur in flight, space flight and industrial environments. The physical and behavioral reaction of organisms to dynamic, thermal, radiative and gravitational stresses. Mechanical, hydraulic and pneumatic performance of body subsystems. Use of the human parameters in the design of protective and prosthetic devices and life support systems. Prereq: Engineering standing and consent of instructor.

ME 590 ELEMENTS OF AEROSPACE TECHNOLOGY. (3)

ME 599 TOPICS IN MECHANICAL ENGINEERING (Subtitle required). (3)
A detailed investigation of a topic of current significance in mechanical engineering such as: computer-aided manufacturing, special topics in robotics, and current topics in heat transfer. May be repeated under different subtitles to a maximum of nine credits. A particular topic may be offered at most twice under the ME 599 number. Prereq: Variable; given when topic is identified.

PREREQUISITE FOR GRADUATE WORK: Students desiring to take any of the following courses should have a thorough working knowledge of chemistry, physics and mathematics.

ME 601 ADVANCED CAE APPLICATIONS. (3)
This course will include development of theory for application to several topics in advanced engineering applications of computers in design. Typical topics include rolling element bearings, fluid film bearings, rotor dynamics, and elasto-plastic analysis. When appropriate, specialized computer programs will be introduced and utilized to illustrate the application of theory and numerical techniques in the areas covered. Prereq: ME 501.

ME 602 DYNAMICS OF DISTRIBUTED MECHANICAL SYSTEMS. (3)
Applications of small-oscillation shell theory to continuous mechanical systems modeled by shells, plates, rings, arches, membranes, beams, etc. Study of natural frequencies, modeshapes, forced-vibration characteristics, system dampings, dynamic influence function, combination of subsystems, active and passive vibration controls and dampings. Prereq: ME 540 or EM 513, or consent of instructor.

ME 604 DYNAMICS OF ROTATING MACHINERY. (3)
Review of dynamic characteristics unique to high speed rotating shafts. Equations of motion for a rotor, including gyroscopic effects. Computational methods, including finite element. Effects of bearings and nonlinearities, stability. Application to design situations. Prereq: EM 313 and ME 501.

ME 606 SEMINAR AND PROJECT IN MANUFACTURING SYSTEMS ENGINEERING. (3)
A project course for manufacturing systems. Course consists of seminar presentations by outside professionals and faculty and a course project on a realistic manufacturing systems assignment. Lecture, two hours; laboratory, two hours. (Same as EE/MFS 606.)
ME 607 ANALYSIS OF METAL CUTTING PROCESSES. (3) Advanced study of metal cutting involving the mechanics of metal cutting including cutting forces, tool-wear/tool-life and temperature analysis, surface finish and integrity, chip control, machinability assessments and advances in cutting tool technology. Prereq: ME 505. (Same as MFS/MSE 607).

ME 608 NONTRADITIONAL MANUFACTURING PROCESSES. (3) This course introduces students to fundamentals of nontraditional manufacturing processes. Theory and implementation of the nontraditional manufacturing processes, such as laser cutting and welding, electro discharge machining, abrasive waterjet machining, rapid prototyping, etc., will be addressed. Prereq: ME 505 or consent of instructor. (Same as MFS 608.)

ME 610 ENGINEERING ACOUSTICS. (3) A comprehensive study of wave propagation in fluids; derivation of the scalar wave equation and a study of its elementary solutions for time harmonic and transient waves in one, two and three dimensions. Radiation and scattering of waves at fluid and solid boundaries. Integral equation solution of the scalar velocity wave potential; numerical methods. Prereq or concur: MA 432G.

ME 611 BOUNDARY ELEMENT METHODS IN ENGINEERING. (3) Introduction of boundary element methods for use in solving common engineering equations, such as the Laplace equation, the Poisson equation, the wave equation, and the diffusion equation. Both the theoretical and numerical aspects of the boundary element technique are presented. Application areas include heat conduction, potential flow problems, acoustic wave propagation, general diffusion, and stress analysis. Prereq: EGR 537 or consent of instructor. (Same as EGR 611.)

ME 620 ADVANCED ENGINEERING THERMODYNAMICS I. (3) Critical treatment of the laws of thermodynamics, relations among thermodynamic properties; stability of systems; thermodynamic processes; selected special topics. Prereq: ME 321.

ME 625 ADVANCED HEAT CONDUCTION. (3) Comprehensive study of heat conduction, derivation of governing equations; discussion of the various boundary conditions; review of classical heat conduction solutions; discussion of current problems, methods of solution and engineering applications of heat conduction. Prereq or concur: MA 432G.

ME 626 ADVANCED HEAT CONVECTION. (3) Comprehensive study of heat convection; derivation of equations of convection of mass, momentum, and energy; boundary layer equations; classical solutions of laminar convection problems; turbulent convection; analogies between momentum and energy. Prereq: ME 325, MA 432G or concurrent.

ME 627 RADIATION HEAT TRANSFER. (3) Principles of thermal radiation, the determination of radiation properties, and the analysis of radiation heat transfer. Results of recent radiation researches are included in the discussions. Prereq: ME 325, MA 432G or concurrent.


ME 631 FLUID DYNAMICS II. (3) A continuation of ME 531 with emphasis on viscous flow. Exact and approximate solutions, boundary layer theory. Jets, wakes, rotating systems, compressible boundary layer and hydrodynamic stability. Prereq: ME 531 or consent of instructor.

ME 634 TURBULENT FLOWS. (3) Physical and analytical description of turbulent flows, isotropic turbulence, boundary layers and shear flows, free turbulence in jets and wakes. Measurement techniques. Prereq: ME 529 or ME 531.

ME 640 ADVANCED ANALYSIS AND SIMULATION OF DYNAMIC SYSTEMS. (3) An extension of ME 540 emphasizing advanced techniques. The concept of random processes in mechanical engineering problems; nonparametric and parametric models. The use of correlation, spectral analysis and digital filtering in data analysis and model building. Prereq: ME 540.

ME 647 SYSTEM OPTIMIZATION I. (3) A course in the theory and application of optimization techniques with emphasis on large engineering systems. Prereq: CS 221, one mathematics course beyond MA 214.

ME 690 ADVANCED ALGORITHMS FOR COMPUTATIONAL FLUID DYNAMICS. (4) Theory and implementation of main algorithms widely used for solving multi-dimensional partial differential equations arising in engineering applications such as fluid dynamics, heat and mass transfer, semiconductor simulation, etc. Numerical solution of steady and time-dependent linear partial differential equations on rectangular domains via finite difference techniques. Linearization methods for treatment of nonlinear problems. Numerical grid generation for transforming irregular domains into rectangular computational grids. Prereq: MA 537, or consent of instructor, and competence with a high-level programming language.

ME 699 TOPICS IN MECHANICAL ENGINEERING (Subtitle required). (3) A detailed investigation of a topic of current significance in mechanical engineering. May be repeated to a maximum of nine credits under different subtitles. A particular topic may be offered at most twice under the ME 699 number. Prereq: Variable; given when topic is identified.

ME 748 MASTER'S THESIS RESEARCH. (0) Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

ME 749 DISSERTATION RESEARCH. (0) Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

ME 768 RESIDENCE CREDIT FOR MASTER'S DEGREE. (1-6) May be repeated to a maximum of 12 hours.

ME 769 RESIDENCE CREDIT FOR DOCTOR'S DEGREE. (0-12) May be repeated indefinitely.

ME 780 SPECIAL PROBLEMS IN MECHANICAL ENGINEERING. (3) This course consists of individual work in one of the various fields of mechanical engineering. May be repeated three times for a maximum of 12 credits. Prereq: Approval of instructor.

ME 783 TOPICS IN ADVANCED SYSTEMS THEORY. (3) A survey and evaluation of current research results in systems theory. A course designed to permit full utilization of specialized abilities of individual and visiting faculty. May be repeated to a maximum of nine credits. Prereq: Consent of instructor.

ME 790 RESEARCH IN MECHANICAL ENGINEERING. (1-9) Work may be taken in any field of mechanical engineering, subject to the approval of the director of graduate studies. May be used to satisfy pre-qualifying examination residency credit. May be repeated to a maximum of 18 hours.

MED 815 FIRST YEAR ELECTIVE, MEDICINE. (1-3) With the advice and approval of his or her faculty adviser, the first-year student may choose approved electives offered by the Department of Medicine. The intent is to provide the student an opportunity for exploration and study in an area which supplements and/or complements required course work in the first-year curriculum. Pass-fail only. Prereq: Admission to first year, College of Medicine.

MED 821 PHYSICAL DIAGNOSIS. (5) This course will provide students with a structured experience in the principles and techniques of physical diagnosis and history taking. Lecture, one hour per week for two semesters; laboratory, three hours per week for two semesters. Prereq: Admission to second year, College of Medicine or consent of instructor and dean.

MED 825 SECOND-YEAR ELECTIVE, MEDICINE. (1-4) With the advice and approval of his or her faculty adviser, the second-year student may choose approved electives offered by the Department of Medicine. The intent is to provide the student an opportunity for exploration and study in an area which supplements and/or complements required course work in the second-year curriculum. Pass-fail only. Prereq: Admission to second-year medical curriculum and approval of adviser.
MFS 505 MODELING OF MANUFACTURING PROCESSES AND MACHINES. (3)
A study of the major manufacturing processes and equipment. Emphasis on mathematical and computer models of these processes, as used in automated manufacturing and control of these processes. Lecture, two hours; laboratory, two hours. Prereq: EM 313 and EM 302. (Same as ME 505.)

#MFS 507 DESIGN FOR MANUFACTURING. (3)
The topics will include fundamentals of concurrent engineering, product life cycle, product specification, standardization, functional requirements and datum features, selection of materials and manufacturing processes, cost analysis, case studies on designing for quality, economy, manufacturability and productivity. Prereq: ME 344 and engineering standing. (Same as ME 507.)

#MFS 512 MANUFACTURING SYSTEMS. (3)
This course introduces students to fundamentals of design, planning and control of manufacturing systems aided by computers. Concepts of control hardware, NC programming languages, software aspects related to NC manufacturing, programmable controllers, performance modeling of automated manufacturing systems, group technology and flexible manufacturing systems, etc. will be addressed. Prereq: Engineering standing. (Same as ME 512.)

MFS 605 SYSTEMS FOR FACTORY INFORMATION AND CONTROL. (3)
Systems approach to manufacturing. Hardware and software for real time control and reporting. Sensor and actuators, controllers, networks, databases, hierarchical and distributed control, CAD/CAM systems, flexible manufacturing systems, group technology, modeling and simulation of factory operations. Lecture, two hours; laboratory, two hours. Prereq: MFS 505. (Same as EE 605.)

MFS 606 SEMINAR AND PROJECT IN MANUFACTURING SYSTEMS ENGINEERING. (3)
A project course for manufacturing systems. Course consists of seminar presentations by outside professionals and faculty and a course project on a realistic manufacturing systems assignment. Lecture, two hours; laboratory, two hours. (Same as EE/ME 606.)

*MFS 607 ANALYSIS OF METAL CUTTING PROCESSES. (3)
Advanced study of metal cutting involving the mechanics of metal cutting including cutting forces, tool-wear/tool-life and temperature analysis, surface finish and integrity, chip control, machinability assessments and advances in cutting tool technology. Prereq: ME 505. (Same as EE/MSE 607.)

MFS 608 NONTRADITIONAL MANUFACTURING PROCESSES. (3)
This course introduces students to fundamentals of nontraditional manufacturing processes. Theory and implementation of the nontraditional manufacturing processes, such as laser cutting and welding, electro discharge machining, abrasive waterjet machining, rapid prototyping, etc., will be addressed. Prereq: ME 505 or consent of instructor. (Same as ME 608.)

MFS 611 ORGANIZATIONAL BEHAVIOR. (3)
A critical examination of behavior and performance within organizations and between organizations. Special attention is paid to the problem of performance at the individual, group, and formal organizational level. Prereq: Graduate School standing. (Same as MGT 611.)

MFS 768 RESIDENCE CREDIT FOR MASTER'S DEGREE. (1-6)
May be repeated to a maximum of 12 hours.

MFS 780 SPECIAL PROBLEMS IN MANUFACTURING SYSTEMS ENGINEERING. (3)
Course consists of specialized individual work in manufacturing systems engineering. Laboratory, nine hours. May be repeated to a maximum of nine credits. Prereq: Approval of instructor.
MGT 301 BUSINESS MANAGEMENT. (3)
A study of planning, organizing and controlling; an interdisciplinary approach; actual
decision-making cases. Prereq: STA 291, ECO 201, 202 and ACC 202, or consent of
instructor.

MGT 320 SURVEY OF PERSONNEL
AND INDUSTRIAL RELATIONS. (3)
Survey of the field of personnel and industrial relations. Introduction of the topics of
manpower planning, selection, placement, training, compensation, administration,
labor-management relationships, hours of work, and health and safety. Prereq: MGT 301 or consent of instructor.

MGT 340 ETHICAL AND REGULATORY ENVIRONMENT. (3)
This course focuses on ethical principles, the nature of the capitalist-collectivist
continuum, government influence on business, and the responsibility of business to
society. Topics to be considered include: major approaches to ethical reasoning, antitrust
law, social regulation, and the economic and social theories that undergird the concept
of the social responsibility of business. Prereq: Junior standing or consent of instructor.

MGT 341 BUSINESS LAW I. (3)
An introduction to the United States legal system and its application to the business
community. Topics to be considered include: contracts, agency, commercial paper,
and real property. Prereq: Junior standing or consent of instructor.

MGT 395 INDEPENDENT STUDY IN MANAGEMENT. (1-6)
Course designed to accommodate students’ independent exploration of specific topics
within management. Course must be under the supervision of an instructor. May be
repeated to a maximum of six credits. Prereq: GPA of 3.0, upper division status, approval
of instructor and chairperson.

MGT 408G WORLD BUSINESS. (3)
Examines the impact of international business upon society from a political, cultural,
and economic point of view. Particular stress will be given to U.S. business in
international operations; its past involvement, present position, and future direction.
Prereq: ECO 201, 202.

MGT 410 ANALYSIS OF ORGANIZATIONAL BEHAVIOR. (3)
The behavior of business organizations and their participants is analyzed in the
contemporary language of social psychology, systems, and models. Various theories
of the firm are reviewed and evaluated. The interdependence of economic, social
and behavioral factors is stressed. Prereq: MGT 301 or consent of instructor.

MGT 422 WAGE AND SALARY ADMINISTRATION. (3)
Analysis of theory and practice in the administration of compensation. Practices and issues related to establishing a position structure, determining rates of pay, making
individual pay decisions, administering benefits, and controlling compensation. Prereq: MGT 320.

MGT 423 MANAGING EMPLOYEE RELATIONS. (3)
Analysis of theory and practices in managing relationships with employees. The emphasis is on organizational conflict, employee commitment, and problems in union and nonunion situations from a managerial perspective. Prereq: MGT 320, MGT 410, ECO 481G or consent of instructor.

MGT 430 SERVICES MARKETING MANAGEMENT. (3)
This course addresses marketing and management issues and problems faced by service
organizations. Marketing and management concepts are broadened and applied to the
service organizations. Topics related to service quality, the marketing mix, and service
delivery are covered. Prereq: MKT 300, MGT 301. (Same as MKT 430.)

MGT 441 BUSINESS LAW II. (3)
A survey of selected business law topics to include: corporations, partnerships, secured
transactions, sales, and bankruptcy. Prereq: MGT 340 or 341, or consent of instructor.

MGT 450 DECISION ANALYSIS. (3)
The purpose of this course is to provide students with methodologies of problem solving
by developing (a) their analytical maturity, (b) their ability to identify problem-generated
alternative actions, and (c) their ability to choose among alternative courses of action.
Prereq: Senior standing in College of Business and Economics and DIS 300. (Same
as DIS 450.)

MGT 491 SMALL BUSINESS MANAGEMENT. (3)
An examination of the problems and decisions inherent in the establishment, financing,
and management of small business firms. An experiential exercise, involving a
consulting assignment to an operating small business in the area, is a central component
of the course. Not to be taken on a pass-fail basis. Prereq: MKT 300, MGT 301, MGT 340, FIN 300 or consent of instructor.

MGT 492 ENTREPRENEURSHIP AND VENTURE CREATION. (3)
An examination of the role of the entrepreneur in society and analysis of the considerations
inherent in starting a business. Topics include market and financial feasibility analysis,
selection of a legal form of organization, estimating resource requirements, and site
selection. Prereq: Senior standing and MKT 300, MGT 301, MGT 340 or MGT 341 and FIN 300.

MGT 499 STRATEGIC MANAGEMENT. (3)
Formulation and evaluation of strategy for single business and multiple business
companies. Prereq: MKT 300, MGT 301, MGT 340, FIN 300 and senior standing.

MGT 608 COMPARATIVE INTERNATIONAL MANAGEMENT. (3)
A comparison of management concepts and practices in different countries and the role
of management in economic development; an interdisciplinary approach emphasizing
the impact of sociological-cultural factors, legal-political factors and education on
management development. Prereq: MGT 301 or consent of instructor.

MGT 611 ORGANIZATIONAL BEHAVIOR. (3)
A critical examination of behavior and performance within organizations and between
organizations. Special attention is given to the problem of performance at the individual,
group, and formal organizational level. Prereq: Graduate School standing. (Same as MFS 611.)

MGT 620 PERSONNEL AND INDUSTRIAL RELATIONS. (3)
Critical examination of theory, research, and managerial practice in the management of
human resources. Particular attention is given to the processes of human resource planning,
staffing, compensation, and the management of employee relations. Prereq: MGT 611, ECO 610, ACC 628, MGT 650, MKT 600, ECO 611, FIN 600, MGT 651.

MGT 624 MANAGEMENT OF INFORMATION RESOURCES. (3)
The course is designed to prepare students to understand and analyze major issues related
to the management of information resources, evaluate the current state of information
resources management within an organization, and participate in the management of such
resources. Prereq: DIS 620 or consent of instructor. (Same as DIS 624.)

MGT 640 LEGAL AND REGULATORY ENVIRONMENT. (3)
The purposes of this course are: 1) to establish an introductory understanding of the
nature, dimensions, and impact of government regulation of business, 2) to explore, in
summary fashion, the rudiments of the capitalist-collectivist continuum, 3) to alert the
student to ethical dilemmas in the decision process, and 4) to exercise the student’s skills
in analysis, writing, and speaking. Prereq: Graduated standing. MGT 611, ECO 610, ACC 628, MGT 650, MKT 600, ECO 611, FIN 600, MGT 651.

MGT 691 INDIVIDUAL WORK IN MANAGEMENT. (1-6)
Students confer individually with the instructor. May be repeated to a maximum of six
credits. Prereq: Consent of the instructor.

MGT 697 TOP MANAGEMENT LEADERSHIP
IN THE CONTEMPORARY BUSINESS ENVIRONMENT. (3)
Political, historical, and philosophical perspectives on the meaning and processes of
top management leadership. Applications of leadership perspective to the development
of organizational culture, ethics and values, stakeholder relations, business-government
relations, and competitiveness. Prereq: Third semester MBA standing.

MGT 699 BUSINESS POLICY AND STRATEGY II. (3)
Strategic issues associated with multi-industry, multi-national, multi-business and
start-up management; strategy implementation and institutionalization; planning
systems. Prereq: MGT 698 or the equivalent.

MGT 700 ADMINISTRATIVE SCIENCE. (3)
Primary emphasis upon the identification and investigation of the schools of thought
concerning the field of administration. Analysis of various theory bases for purposes
of integration and generalization will also make up a major portion of the course. Prereq:
MGT 301 or consent of instructor.

MGT 711 ORGANIZATIONS AND EXTERNAL SYSTEMS. (3)
Systems analysis is used to examine organizations from two perspectives: 1) intra-
organizational linkages among goals, technical subsystems and structural subsystems,
and 2) organizational linkages with institutions, parties and cultures in its environment.
Prereq: Consent of instructor.
MI 615 MOLECULAR BIOLOGY. (3)
An integrative and functional approach to the regulatory aspects of DNA, RNA and proteins in procaryotic and eucaryotic cells. Lectures and discussions with readings in original literature. Prereq: A course in genetics (e.g. BCH 404G) and a course in nucleic acids and elementary molecular biology (e.g. BCH 502) or consent of instructor. (Same as BCH/BIO 615.)

**MI 616 MOLECULAR NEUROBIOLOGY.** (4)
This course provides knowledge base and analytical skills in the field of molecular neurobiology. An in-depth introduction to current technologies, their rationale and limitations, will be the focus to address normal brain function and neuropathological conditions. Prereq: BCH 501, 502, NEU 605, or consent of instructor. (Same as ANA/BIO 618.)

MI 685 ADVANCED IMMUNOBIOLOGY. (4)
An introductory level graduate course surveying current trends in immunology including the organization and structure of cells relevant to immunity, immunocompatability, types of immune responses, cellular immunology, immunogenetics and immunopathology. Prereq: BCH 401G, or BCH 501 or 502 or equivalent, or consent of instructor. (Same as BIO 685.)

MI 707 CONTEMPORARY TOPICS IN IMMUNOLOGY. (2)
This course will deal with controversial and evolving areas of immunology. Lectures in a given topic will be accompanied by student discussion of contemporary literature. Prereq: MI 685 or equivalent or consent of instructor. (Same as BIO 707.)

MI 710 SPECIAL TOPICS IN MICROBIOLOGY. (2)
A variety of topics related to modern molecular and cell biology. Prereq: Consent of instructor.

MI 720 MICROBIAL STRUCTURE AND FUNCTION. (4)
Molecular basis of structure and function in unicellular microbes. Molecular genetic and structural approaches to the analysis of bacterial architecture growth, division, and differentiation. Prereq: Consent of instructor, BCH 501, BCH 502, and BIO 476G or equivalent. (Same as BIO 720 and OBI 720).

MI 748 MASTER’S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

MI 749 DISSERTATION RESEARCH. (0)
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams. (Same as MB 749.)

MI 768 RESIDENCE CREDIT FOR MASTER’S DEGREE. (1-6)
May be repeated to a maximum of 12 hours. (Same as MB 768.)

MI 769 RESIDENCE CREDIT FOR THE DOCTOR’S DEGREE. (1-12)
May be repeated indefinitely. (Same as MB 769.)

MI 772 SEMINAR IN MICROBIOLOGY. (0-1)
Review of current literature in microbiology; presentation of papers on work in progress in the department or on assigned topics; reports on meetings of national and international scientific and professional societies and symposia. Required of all graduate students. Two hours per week. May be repeated nine times for a maximum of 10 credits. (Same as BIO 772.)

MI 78 RESEARCH IN MICROBIOLOGY. (1-9)
May be repeated to a maximum of 24 credits. Prereq: Consent of instructor. (Same as BIO 789.)

MI 811 IMMUNOLOGY FOR MEDICAL STUDENTS. (3)
An introduction to the basic principles of immunobiology, immunocompatability, and clinical immunology. Prereq: Admission to the College of Medicine.

MI 812 GENETICS FOR MEDICAL STUDENTS. (2)
Introduction to the basic principles of gene transmission, molecular genetics, and cytology as related to human genetics. Prereq: Admission to the College of Medicine.

MI 815 FIRST-YEAR ELECTIVE, MEDICAL MICROBIOLOGY AND IMMUNOLOGY. (1-3)
With the advice and approval of his or her faculty adviser, the first-year student may choose approved electives offered by the Department of Medical Microbiology and Immunology. The intent is to provide the student an opportunity for exploration and study in an area which supplements and/or complements required course work in the first-year curriculum. Pass-fail only. Prereq: Admission to first year, College of Medicine.
MKT 300 MARKETING MANAGEMENT. (3)
The literature and problems in the retail distribution of consumers’ goods, wholesale distribution of consumers’ goods, industrial goods, sales organizations, sales promotion and advertising, and price policies. Prereq: ECO 202 or consent of instructor.

MKT 310 BEHAVIORAL SYSTEMS IN MARKETING. (3)
The application of psychology, sociology, and anthropology to marketing. Includes such topics as consumer decision process, communications, interpersonal behavior, innovation. Prereq: MKT 300.

MKT 320 RETAIL AND DISTRIBUTION MANAGEMENT. (3)
Analysis of the functions, structure, policies, and performance of distribution channels and institutions. The course objective is to provide students with an understanding of concepts and decision making tools used in managing manufacturer-retailer relationships and distribution costs at both the channel and retail level. The course is also concerned with the legal and socio-economic impact of distribution trends and practices. Prereq: MKT 300.

MKT 340 INTRODUCTORY MARKETING RESEARCH. (3)
Managerial applications of research in marketing decision making. The course objective is to provide students with expertise in defining information needs, selecting information sources and organizing information in decision-making contexts. Application of major concepts will be illustrated in marketing policy areas. Prereq: MKT 300, ECO 391.

MKT 390 SPECIAL TOPICS IN MARKETING (Subtitle required). (1-3)
Readings, projects, lecture and/or discussion to illuminate current topics of special interest or concern in marketing. May be repeated to a maximum of six credits. May not be repeated under the same title. A particular topic may be offered at most twice under the MKT 390 number. Prereq: Consent of instructor.

MKT 395 INDIVIDUAL WORK IN MARKETING. (1-6)
Student develops a specific program with instructor. One or more papers is typically expected. May be repeated to a maximum of six credits. Prereq: GPA of 3.0 in major, approval of instructor and chairperson.

MKT 400 PROMOTION MANAGEMENT. (3)
The objectives of the Promotion Management course are to develop awareness and understanding of the role and functions of promotion within firms and within society and to explicitly attempt to develop student thinking skills, i.e., problem identification, problem analysis, and problem solving, in the area of promotion. Prereq: MKT 300 and MKT 310 or permission of instructor.

MKT 410 PERSONAL SELLING AND SALES MANAGEMENT. (3)
A detailed exposure to personal selling techniques. Emphasis placed on sales process, especially planning and delivery of sales presentations. Selected sales management topics include recruiting, training, motivating and evaluating sales people, as well as ethical and legal issues. Prereq: MKT 300 and marketing majors only.

MKT 420 CONTEMPORARY MARKETING PROBLEMS. (3)
An examination of selected areas in the field of marketing with a focus on contemporary problems. Emphasis will be placed on individual work by students. Prereq: MKT 300 and senior standing.

MKT 430 SERVICES MARKETING MANAGEMENT. (3)
This course addresses marketing and management issues and problems faced by service organizations. Marketing and management concepts are broadened and applied to the service sector. Topics related to services marketing and marketing service delivery are covered. Prereq: MKT 300, MKT 340, ECO 391.

MKT 440 ADVANCED MARKETING RESEARCH. (3)
Training in the application of scientific method and analytical techniques in the fields of marketing. Emphasis on the analysis of empirical data. Prereq: MKT 300, MKT 340, ECO 391.

MKT 450 MARKETING STRATEGY AND PLANNING. (3)
An examination of and participation in analytical processes for managerial marketing decisions. Topics will include such problem areas as product planning, distribution systems, advertising strategies, information systems, pricing decisions and buying behavior. Prereq: MKT 300 and two other marketing courses.

MKT 600 MARKETING MANAGEMENT. (3)
This course is designed to provide students with an understanding of: the role of marketing function in an organization; the types of marketing decisions and analytical procedures involved in making each decision; the overall marketing planning process; and, the impact of the social, economic, and legal environment on marketing decisions. Prereq: Completion of first semester of MBA program, graduate standing, MGT 611, ECO 610, ACC 628, MGT 650.

MKT 601 MARKETING RESEARCH. (3)
MKT 601 entails a vigorous examination of research methodology applicable to marketing situations. Emphasis is placed on 1) experimental design, 2) survey design and administration, and 3) analytical procedures. Practical application of marketing research is stressed. Legal and social issues are also examined. Prereq: MKT 600, MGT 650, and MGT 651.

MKT 621 PRODUCT MANAGEMENT. (3)
Examines the analytical, decision making, and planning concepts and tools available to market/product/brand managers. Specific decisions to be addressed include: product policy formulation, the selection of product market strategies, new product development, product-line modifications and deletions, and organizational implications. Prereq: Completion of first year of MBA program or permission of instructor.

MKT 622 SALES MANAGEMENT. (3)
MKT 622 entails a comprehensive examination of the planning, implementing, and controlling of personal contact programs designed to achieve the sales objectives of the firm. Managerial decision-making is emphasized through the application of lecture material, readings, and case studies. Prereq: Completion of first year of MBA program or permission of instructor.

MKT 623 MARKETING IN SERVICE AND NONPROFIT ORGANIZATIONS. (3)
The purpose of the course is to broaden and apply the conceptual system of marketing to the marketing problems of service and nonprofit organizations. Concepts such as marketing mix, marketing segmentation, market positioning, channels of distribution and others will be applied to the problems of service and nonprofit organizations. Prereq: MKT 600 or permission of the instructor.
MKT 624 INTERNATIONAL MARKETING MANAGEMENT. (3) Examine the broad implications for marketing strategy and decision making of the firm in an international context. Addresses comprehensive survey of firm entry strategies, marketing mix decisions, product policies, and environmental factors in a global context. Context-based problems such as implicit barriers to entry through distribution channel management will also be addressed. Prereq: MNG 600 or permission of instructor.

MKT 695 INDIVIDUAL WORK IN MARKETING. (1-6) Students confer individually with the instructor. May be repeated to a maximum of six credits. Prereq: Consent of instructor.

MKT 700 SEMINAR IN MARKETING MANAGEMENT. (3) A doctoral seminar directed toward the basic decision areas of marketing management. Emphasis is on traditional, classic, and contemporary literature that presents important conceptualizations of marketing practices and empirical research in marketing management. Prereq: Consent of instructor.

MKT 710 SEMINAR IN CONSUMER BEHAVIOR. (3) The seminar is specifically designed for the needs of doctoral students in marketing in that it emphasizes empirical research, theory and methodology as they relate to consumer behavior. The objectives of the seminar are (1) to familiarize the students with the literature of consumer behavior, (2) to stimulate critical thinking about existing research, and (3) to evaluate existing theories, conceptualizations, and models of buyer behavior. Prereq: Consent of instructor.

MKT 720 SEMINAR IN MARKETING THEORY. (3) A survey, analysis and evaluation of the current research in marketing theory. Detailed attention is given to problems of determining the meaning and boundaries of marketing theory. Emphasis is placed on introducing the student to the substantive content of marketing theories and their methodologies. Prereq: MKT 600 or consent of instructor.

MKT 771 SEMINAR IN BUSINESS ADMINISTRATION. (3) Each semester some topics currently discussed in scholarly journals in business administration will be studied intensively. May be repeated to a maximum of nine credits. Prereq: Consent of instructor.

MKT 781 INDEPENDENT WORK IN MARKETING. (1-6) Designed for advanced students who undertake research problems to be conducted in regular consultation with the instructor. May be repeated to a maximum of six credits. Prereq: Consent of instructor.

MNG Mining Engineering

MNG 101 INTRODUCTION TO MINING ENGINEERING. (1) Orientation to the mining engineering profession.

MNG 102 ELEMENTS OF MINING ENGINEERING. (2) Introduction to key mining engineering activities and functions; principles of mine planning and design, mining methods and equipment, and health and safety subsystems. Prereq: MNG 101.

MNG 211 SURVEYING. (4) A comprehensive course in the art and science of surveying as applied to civil and mining engineering, including the use and care of surveying instruments; measurement of horizontal and vertical distances, angles and directions; collection of ground and underground data for the design and layout of roads, buildings, various mineral workings and other structures; and some aspects of the precise determination of position and direction for survey control. Lecture, three hours; laboratory, three hours. Prereq: CE 106, CE 121 or MNG 102, MA 114. (Same as CE 211.)

MNG 222 MINE LAW AND SAFETY. (3) Mine laws, including safety regulations and interpretations for engineers and supervisors. Prereq: MNG 102.


MNG 302 MINERALS PROCESSING LABORATORY. (1) Application of the principles studied in MNG 301. Laboratory, two hours. Prereq or concur: MNG 301.

MNG 312 COMPUTER METHODS IN MINING ENGINEERING. (3) Use of microprocessors for data acquisition, process control, planar digitizing and plotting. Remote accessing of standard libraries of mining engineering and statistical packages. Modeling of mine systems. Prereq: CS 221.


MNG 341 MINE VENTILATION. (3) Hazards of dust and gaseous contamination of mine atmosphere, air dilution requirements, flow distribution in mine network, computer analysis of the ventilation network, natural ventilation and fans. Lecture, two hours; laboratory, three hours. Prereq: PHY 231, CE 341 and engineering standing.

MNG 371 SEMINAR. (1) Oral presentation of a student-developed technical paper appropriate to mining engineering. Review of speaking skills, organization and time management abilities, and use of audio-visual aids. Lecture, two hours per week. Prereq: Engineering Standing.

MNG 395 INDEPENDENT WORK IN MINING ENGINEERING. (1-6) Individual work on some selected problem in the field of mining engineering. May be repeated for a maximum of six credits. Prereq: Consent of department chairperson and the instructor.

MNG 431 MINE SYSTEMS ENGINEERING. (3) Aspects of industrial and geological engineering for mine systems engineering design. Course consists of reserve engineering, pre-systems modeling and interfacing systems to reserves. Prereq: STA 381, MNG 332.


MNG 490G EXPLOSIVES AND BLASTING ENGINEERING. (3) Types of commercial explosives, explosive properties; systems of initiation, charging methods, design of benches, design of blasting rounds; explosives applications in mining and other fields; damage control; and safe blasting practices. Prereq: Engineering standing or consent of instructor.

MNG 551 ROCK MECHANICS. (4) Determination of the physical properties of rocks, rock mass classification, stress around mine openings, strain and displacement of the rock mass, rock reinforcement and support, stress interaction and subsidence, strata control. Lecture, three hours; laboratory, three hours per week. Prereq: EM 302, EM 303, GLY 240 and Engineering standing; or consent of instructor.


MNG 563 SIMULATION OF MINE PRODUCTION SYSTEMS. (3) Discrete event simulation and its application to performance analysis of mine production systems. Topics include concepts for characterizing production systems, approaches to structuring simulation models, instruction in a simulation language, and techniques for comparing alternative system designs and control strategies. Applications are made in modeling mine face operations, conveyor networks, and discrete vehicle transport systems. Prereq: CS 221, STA 381 and MNG 431. (Same as OR 563.)

MNG 572 ADVANCED COAL PREPARATION. (3) Study of economic and environmental factors in cleaning a specific coal, laboratory tests for process selection, laboratory testing of alternative procedures leading to design of plant. Lecture, two hours; laboratory, three hours per week. Prereq: MNG 301 and Engineering standing.
MNG 575 COAL PREPARATION DESIGN. (3)
Design a coal preparation plant by integrating unit operations preceded by certain back- up laboratory experiments. Cost sensitivity analysis of competing design schemes will be determined on a selected coal. Lecture: two hours; laboratory: three hours per week. Prereq: MNG 301 or equivalent.

MNG 581 MINE VALUATION AND GEOSTATISTICS. (3)
Geostatistics-based ore reserve estimation and engineering economics applied to estimation of the economic value of a mineral property. Topics include treatment of the spatial distributions of ore grade as regionalized variables, covariance stationary processes, variograms, volume/variance relations, ordinary kriging, block selection decisions under uncertainty, cash flow analysis, capital costing techniques, mineral pricing, and risk assessment. Prereq: STA 381.

MNG 591 MINE DESIGN PROJECT I. (1)
Students will undertake a design project consisting of reserve analysis on a given mine property. They will calculate minable reserves and analyze mining and quality properties of coal. Each student will write a report supported by maps and will present it orally before a group of peers and invited experts. Lecture, one hour; laboratory, one hour per week. Prereq: MNG 332.

MNG 592 MINE DESIGN PROJECT II. (2)
Each student will undertake one or more major design projects such as the overall design of a mining system, including design of major components of the system and an economic evaluation. Each student will write one or more individual reports, which will also be presented orally before a group of peers and invited experts. Lecture, one hour; laboratory, two hours per week. Prereq: MNG 341, MNG 551, MNG 591.

MNG 599 TOPIC IN MINING ENGINEERING. (2-3)
A detailed investigation of a topic of current significance in mining engineering. May be repeated to a maximum of six credits, but only three credits can be earned under the same title. A particular topic may be offered at most twice under the MNG 599 number. Prereq: Engineering standing and consent of instructor.

MNG 632 MINE PLANT MACHINERY II. (3)
Analysis of major bulk handling media, including rail haulage, conveyor belt haulage, hoisting, and off-highway trucks. Use of available computer software for evaluation, selection, and design of haulage equipment by mathematical modeling and simulation. Encumbered space in mining, velocity-clearance curves, and optimal sizing of mobile handlers. Prereq: MNG 592 or consent of instructor.

MNG 634 ADVANCED MINE ENGINEERING. (3)
Procedures and methods of obtaining data and analyzing mine systems for efficient development and exploitation of a mining property. Course includes applications of operation research techniques. Prereq: CE 555, CS/MA/STA 482G.

MNG 637 ROCK SLOPE STABILITY AND DESIGN. (3)
Design and stability analysis of rock slopes using analytical, empirical, and numerical approaches, engineering geological data, groundwater pressure, blasting, and remedial measures. Prereq: MNG 551.

MNG 641 ADVANCED MINE VENTILATION. (3)
Planning, designing and redesigning the ventilation systems using computers; data acquisition (ventilation survey); non-steady state flow in mine openings; influence of the ventilation conditions upon the dynamics of the methane concentration; automation of the ventilation system. Lecture, two hours; laboratory, two hours. Prereq: MNG 341.

MNG 661 MINE CONSTRUCTION ENGINEERING II. (3)
Advanced analysis of underground capital openings in mines with emphasis on linings. Design under adverse geological conditions and unusual technological requirements. Special and unique construction methods and equipment. Prereq: MNG 561.

MNG 681 GEOSTATISTICS II. (3)
A second course in geostatistics for mine planning and geotechnical applications. Topics include coRegionalized variables and cokriging, non-parametric geostatistics (indicator, probability, and soft kriging), loss functions and optimum predictors for ore selection decisions, conditional simulation—techniques and applications. Prereq: MNG 581.

MNG 690 ADVANCED MINERAL BENEFICIATION ENGINEERING. (3)

MNG 691 SIMULATION OF MINERAL PROCESSING CIRCUITS. (3)
Flowsheet modeling and analysis for coal preparation and ore dressing plants. Topics include unit models for comminution, gravity separation, and froth flotation; relevant techniques for solving systems of nonlinear equations; convergence acceleration techniques; sequential modular, simultaneous modular, and equation-solving flow-sheeting frameworks; flowgraph techniques for analysis of certain classes of mineral processing circuits. Prereq: MNG 575.

MNG 699 TOPICS IN MINING ENGINEERING (Subtitle Required). (3)
A detailed investigation of a topic of current interest in mining engineering. May be repeated to a maximum of six credits, but only three credits may be earned under the same subtitle. A particular topic may be offered only twice under the MNG 699 number. Prereq: Consent of instructor.

MNG 748 MASTER’S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

MNG 749 DISSERTATION RESEARCH. (0)
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

MNG 768 RESIDENCE CREDIT FOR THE MASTER’S DEGREE. (1-6)
May be repeated to a maximum of 12 hours.

MNG 769 RESIDENCE CREDIT FOR DOCTOR’S DEGREE. (0-12)
May be repeated indefinitely.

MNG 771 SEMINAR IN MINING ENGINEERING. (1)
Review of current research in specific areas of mining engineering. Required of all graduate students. Prereq: Graduate classification.

MNG 780 SPECIAL PROBLEMS IN MINING ENGINEERING. (1-6)
Individual work on some selected design problems in one area of mining engineering. May be repeated to a maximum of six credits. Prereq: Approval of the chairperson of the department.

MNG 790 SPECIAL RESEARCH PROBLEMS IN MINING ENGINEERING. (1-9)
Individual work on some selected problems in one of the various fields of mining engineering. Laboratory and field measurements, six hours. May be repeated to a maximum of nine credits. Prereq: Approval of the Director of Graduate Studies.

MS Military Science

(ARMY ROTC)

BASIC COURSES

†MS 101 AMERICAN MILITARY HISTORY I. (2)
A course examining the U.S. Army as an institution, specifically looking at the roles and relationships of the Army within our democracy. Course also provides a look at the Army officer and unique aspects of the military profession.

*MS 103 ROLE OF THE U.S. ARMY. (2)
A course examining the U.S. Army as an institution, specifically looking at the roles and relationships of the Army within our democracy. Course also provides a look at the Army officer and unique aspects of the military profession.

*MS 104 INTRODUCTION TO LEADERSHIP. (2)
This course is designed to acquaint the student with the fundamental skills necessary to be a leader, both in military and civilian context. Course also covers basic military map reading skills.

*MS 203 AMERICAN MILITARY HISTORY. (2)
Study of the development of the U.S. from a military perspective. Pre-parallel development of technology and warfare; and emphasis on the evaluation of military leadership from the historically tested principles of warfare from the Civil War to the present.

#MS 204 EFFECTIVE MILITARY COMMUNICATIONS. (2)
This course provides instruction and practical experience in the art of speaking and writing in the Army style. Students will demonstrate competency through a series of oral presentations and writing assignments. Small unit tactics and map reading skills will also be used in the implementation of the oral presentations.
**ADVANCED COURSES**

**MS 301 LEADERSHIP AND MANAGEMENT I.** (3)  
Course of study in development of basic skills required to function as a manager; study of leadership styles, group dynamics, communications, motivation and military instruction methods; and study of the soldier and exercise of command. Prereq: MS 201, 202 graduate or undergraduate student (male or female), successful completion of basic course or basic camp, physically fit to pursue program; consent of PMS.

**MS 302 ADVANCED TACTICS.** (3)  
Small unit tactics and communications, organization and mission of combat arms units; leadership and the exercise of command. Prereq: MS 201, 202, graduate or undergraduate student (male or female), successful completion of basic course or basic camp, physically fit to pursue program; consent of PMS.

**MS 341 LEADERSHIP AND MANAGEMENT II.** (3)  
An advanced study of logistics, operations, military administrations, personnel management, military justice, world change and military implications, service orientation and leadership training. Prereq: MS 301, 302.

**MS 342 COMMAND MANAGEMENT.** (3)  
An advanced study of logistics, operations, military administration, personnel management, military justice, world change and military implications, service orientation and leadership training. Prereq: MS 301, 302.

**MS 350 MILITARY SCIENCE LABORATORY.** (1)  
A hands-on practicum which exposes the student to the military skills required for basic technical and tactical competence as an Army officer. The course affords the student opportunities to develop and refine his/her leadership style and abilities under differing conditions. Laboratory, two hours per week and two week-end exercises. May be repeated to a maximum of four credits. Concur: MS 301, 302, or 342.

**MS 395 INDEPENDENT STUDY IN LEADERSHIP.** (1-2)  
Advanced study in leadership. Students are under guidance and confer individually with faculty on approved topic(s). A written report or paper is expected and will be filed in the chairperson’s office. May be repeated to a maximum of four credits. Prereq: Completion of MS 302 and approval of PMS.

**MSC Modern Studies Curriculum**

**MSC 105 MINI-COLLEGE I: (TWO SUBTITLES REQUIRED).** (1-5)  
A course for first semester freshmen enrolling in a mini-college. Students may enroll in up to nine (9) hours of A&S mini-college credit concurrently, as required by the mini-college. Prereq: Enrollment in a designated UK mini-college.

**MSC 106 MINI-COLLEGE II: (TWO SUBTITLES REQUIRED).** (1-5)  
A course for second semester freshmen enrolling in a mini-college. Students may enroll in up to nine (9) hours of A&S mini-college credit concurrently, as required by the mini-college. Prereq: Enrollment in a designated UK mini-college.

**MSC 107 NATURAL SCIENCE I.** (4)  
A multidisciplinary course on the scientific view of the origin, nature, and evolution of the universe. The two-semester sequence explores the relationships among astronomy, biology, chemistry, geology, and physics in historical, cultural, and environmental contexts. This course emphasizes aspects of physics, astronomy, and chemistry. Lecture, three hours; laboratory/practicum/field/trips, three hours per week. Prereq: Enrollment in a UK mini-college.

**MSC 108 NATURAL SCIENCE II.** (4)  
A multidisciplinary course on the scientific view of the origin, nature, and evolution of the universe. The two-semester sequence explores the relationships among astronomy, biology, chemistry, geology, and physics in historical, cultural, and environmental contexts. This course emphasizes aspects of geology and biology. Lecture, three hours; laboratory/practicum/field/trips, three hours per week. Prereq: Enrollment in a UK mini-college.

**MSC 205 MINI-COLLEGE IIIA: (TWO SUBTITLES REQUIRED).** (1-5)  
A course for sophomores enrolling in a mini-college. Students may enroll in up to nine (9) hours of A&S mini-college credit concurrently, as required by the mini-college. Prereq: Enrollment in a designated UK mini-college.

**MSC 206 MINI-COLLEGE IVA: (TWO SUBTITLES REQUIRED).** (1-5)  
A course for sophomores enrolling in a mini-college. Students may enroll in up to nine (9) hours of A&S mini-college credit concurrently, as required by the mini-college. Prereq: Enrollment in a designated UK mini-college.

**MSE Materials Science and Engineering**

**MSE 101 MATERIALS ENGINEERING.** (1)  
An introduction to the materials engineering profession. Professional growth, conduct, ethics and organizations. Introduction to the techniques of materials engineering.

**MSE 102 METALS TECHNOLOGY.** (1)  
A laboratory course introducing students to molding, pattern making, casting, cutting, welding and heat treating. Laboratory, three hours per week.

**MSE 201 MATERIALS SCIENCE.** (3)  
Microscopic and macroscopic structure as related to the properties of materials with engineering applications. Prereq or concur: MA 114 and freshman chemistry.

**MSE 212 ELECTRONIC PROPERTIES OF MATERIALS.** (3)  
Modern ideas on the engineering properties of solids, crystallographic properties; relationship of properties to structure and electronic properties of materials. Prereq: PHY 232 and 242, MA 214 concurrent.

**MSE 361 STRUCTURE AND PROPERTIES OF MATERIALS I.** (4)  
The principles of phase diagrams of materials; dependence of physical, mechanical and electrical properties on microstructure of materials. Solidification, deformation and softening processes in materials. Lecture, three hours; laboratory, three hours per week.

**MSE 362 STRUCTURE AND PROPERTIES OF MATERIALS II.** (4)  
Diffusion in materials, aging processes; the iron-carbon system, environmental degradation of materials. Lecture, three hours; laboratory, three hours per week. Prereq: MSE 361 and engineering standing.

**MSE 395 INDEPENDENT WORK IN MATERIALS ENGINEERING.** (1-3)  
Research for undergraduate departmental students. May be repeated to a maximum of 12 credits. Prereq: Department major and approval of chairperson.

**MSE 421 SOLIDIFICATION AND CASTING.** (4)  
Ferrous and nonferrous foundry practice. Application of engineering principles to the design and production of castings. Lecture; three hours; laboratory; three hours. Prereq: MSE 201, PHY 232.

**MSE 450 TRANSPORT PHENOMENA FOR MATERIALS ENGINEERS.** (3)  
The fundamentals of transport phenomena will be developed with emphasis on applications relating to materials engineering. Emphasis will be on heat transfer. Mass and momentum transfer will be demonstrated by analogy to heat transfer. Prereq: CME 210.

**MSE 451 MATERIALS THERMODYNAMICS.** (3)  
Solution thermodynamics; partial molar quantities; ideal and non-ideal solutions; application of thermodynamics to phase equilibria; heterogeneous equilibria; free energy-composition relationships; temperature-pressure relationships; nitrogen in iron and steel and the iron-carbon system. Prereq: CME 210.

**MSE 480 MATERIALS DESIGN.** (3)  
A capstone engineering design experience involving analysis, with some treatments of engineering economics of real processes, design of materials, fabrication problems and techniques, and prediction of model material systems.

**MSE 506 MECHANICS OF COMPOSITE MATERIALS.** (3)  
A study of structural advantages of composite materials over conventional materials, considering high strength-to-weight and stiffness-to-weight ratios. Fiber reinforced, laminated and particulate materials are analyzed. Response of composite structures to static and dynamic loads, thermal and environmental effects, and failure criteria are studied. Prereq: EM 302, engineering standing or consent of instructor. (Same as EM 506.)
MSE 512 ELECTRONIC MATERIALS AND PROCESSING. (3)
Methods to produce and process electronic materials: solidification of electronic materials, stress-strain considerations in processing, defect control, diffusion of dopants, oxidation and methods of structural, electronic and chemical characterization. Prereq: Engineering standing or graduate level.

MSE 531 POWDER METALLURGY. (3)
Study of the principles of powder metallurgy relating to alloys of unusual compositions, metal and nonmetal combinations, porous and laminated products, composite metals, and high-melting alloys. Prereq: Consent of instructor.

MSE 535 MECHANICAL PROPERTIES OF MATERIALS. (3)
Introductory elasticity and plasticity theory; crystallographic nature of slip and twinning; fracture. Prereq: MSE 201, EM 302 and engineering standing or consent of instructor.

MSE 536 CERAMIC ENGINEERING (3)
The nature of ceramic materials. The forming and thermal treatment of ceramic products. Consideration of the various properties usually encountered and required of ceramic materials inclusive of cements. Lecture and recitation, three hours. Prereq: Consent of instructor.

MSE 538 DEFORMATION PROCESSING. (4)
Solidification of molten alloys; fundamentals of metal working; application of metal working theories to forging, rolling, extrusion, drawing and sheet forming. Lecture, three hours; laboratory, three hours per week. Prereq: Engineering standing.

MSE 542 EXTRACTIVE METALLURGY. (4)
The principles and processes employed in the preparation, treatment and production of various metals of economic or strategic importance; process economics. Lecture, three hours; laboratory, three hours per week. Prereq: CHE 440G or CHE 444G or MSE 451.

MSE 550 CORROSION. (3)
The fundamental principles of corrosion control and the basic mechanisms related to a better understanding of the causes of corrosion. The application of principles to practical situations. Prereq: CHE 107, MSE 201.

MSE 552 POLYMERIC MATERIALS. (3)
Relating properties to structure; properties of polymer materials; mechanical, electrical and thermal properties of amorphous and crystalline polymers, molding and fabrication, polymers as additives, biomedical application, selection of polymers, design. Prereq: CHE 230 or CHE 236, or consent of instructor. (Same as CME 552.)

MSE 554 CHEMICAL AND PHYSICAL PROCESSING OF POLYMER SYSTEMS. (3)
Theory related to the chemical and physical processing of polymer systems, polymer chemistry, non-Newtonian flow behavior, stress and strain tensors, polymer processing operations and technology. Prereq: CHE 232 and CHE 425, or consent of instructor. (Same as CME 554.)

MSE 556 INTRODUCTION TO COMPOSITE MATERIALS. (4)
Applications, materials selection and design of composite materials. Relation between properties of constituent materials and those of composite. Processing methods for materials and for some structures. Lab focuses on preparation and testing of composite materials and their constituents. Lecture, three hours; laboratory, three hours per week. Prereq: MA 214, CHE 236, PHY 232, MSE 201, or consent of instructor. (Same as EM 556.)

MSE 558 PRINCIPLES OF POLYMER CHARACTERIZATION AND ANALYSIS. (3)
A lecture course exploring the fundamental chemical and physical aspects of a range of characterization methods as applied to polymeric systems; the primary objective will be the development of a broad understanding of the various tools available for polymer characterization both on the molecular level and as bulk materials. Prereq: CHE 320, ME 330, or consent of instructor. (Same as CME 558.)

MSE 561 ELECTRIC AND MAGNETIC PROPERTIES OF MATERIALS. (3)
Study of dielectric and magnetic materials. Topics include dielectric relaxation, conduction and breakdown mechanisms, liquid crystals, ferroelectrics, magnetic resonance and relaxation, measurement techniques. Prereq: MSE 212 and PHY 361 or EE 461G or consent of instructor. (Same as EE 561.)

MSE 568 FIBER OPTICS. (3)
The course presents theory and practice related to (a) fiber optic cable and their fabrication, (b) fiber optic transmitters and detectors, (c) fiber optic communication systems and (d) fiber optic remote sensors. Prereq: EE 468G. (Same as EE 568.)

MSE 599 TOPICS IN MATERIALS SCIENCE AND ENGINEERING (Subtitle required). (2-3)
A detailed investigation of a topic of current significance in materials science and engineering such as biomedical syntheses, electronic properties of materials, advances in metal working, history of material technology, quantitative metallography. Theory of dislocations, scanning electron microscopy. May be repeated to a maximum of six credits, but only three credits can be earned under the same title. A particular topic may be offered at most twice under the MSE 599 number. Prereq: Variable, given when topic identified.

PREREQUISITE FOR GRADUATE WORK: Students desiring to take any of the following courses should have a thorough working knowledge of chemistry, physics and mathematics.

*MSE 607 ANALYSIS OF METAL CUTTING PROCESSES. (3)
Advanced study of metal cutting involving the mechanics of metal cutting including cutting forces, tool-wear/tool-life and temperature analysis, surface finish and integrity, chip control, machinability assessments and advances in cutting tool technology. Prereq: ME 505. (Same as ME/MFS 607)

MSE 632 ADVANCED MATERIALS SCIENCE. (3)
Classification of solids, atomic structure and bonding, relation of structure to properties, deformation behavior and failure. Prereq: Consent of instructor.

MSE 635 ADVANCED MECHANICAL METALLURGY. (3)
Theory of dislocations in crystals and their role in strength, plasticity, work hardening and fracture of crystalline solids. Prereq: Consent of instructor.

MSE 636 DISLOCATION THEORY. (3)
Fundamentals of elastic theory of dislocations and the kinematics of dislocation motion: straight dislocations, curved dislocation, self-energies, interactions with other crystal defects, dislocation multiplication. Prereq: MSE 535 or EM 531 or equivalent.

MSE 650 ADVANCED MATERIALS THERMODYNAMICS. (3)
Study of reactions of materials with chemical environments. Introduction to irreversible thermodynamics. Emphasis on current literature. Prereq: Consent of instructor.

MSE 659 ADVANCED PHASE DIAGRAMS. (3)

MSE 661 ADVANCED PHYSICAL METALLURGY I. (3)
Study of the theory of phase transformations in metallic systems. Analysis of rate controlling processes for nucleation and growth controlled phase changes and for order-disorder reactions. Prereq: MSE 362 and 412 or consent of instructor.

MSE 662 ADVANCED PHYSICAL METALLURGY II. (3)
Solidification theory and mechanisms. Diffusion in solids. Prereq: MSE 661 or consent of instructor.

MSE 665 CRYSTALLOGRAPHY AND X-RAY ANALYSIS. (4)
Elements of crystallography, nature of X-rays, diffraction by crystal lattice, the structure factor and crystal structure determinations in crystal lattices, X-ray camera and diffractometer techniques and application of these to determination of phase diagrams, preferred orientation and residual stresses. Lecture, three hours; laboratory, three hours. Prereq: MSE 361.

MSE 666 DIFFRACTION METHODS IN MATERIALS SCIENCE. (4)
Application of thin foil electron transmission methods to the study of the defect structure in crystalline solids, theory of electron diffraction contrast phenomena, sample preparation, X-ray theory and methods applied to the study of deformation characteristics, order-disorder transformations, and crystal structure analysis. Lecture, two hours; laboratory, six hours. Prereq: MSE 665.

MSE 699 ADVANCED TOPICS IN MATERIALS SCIENCE AND ENGINEERING (Subtitle required). (3)
A detailed investigation of an advanced topic of current significance in materials science and engineering such as (1) nanometer materials, (2) structures of superconductors and (3) materials characterization under high rates of deformation. May be repeated under different subtitles to a maximum of nine credits, but only three credits can be earned under the same title. A particular topic may be offered at most twice under the MSE 699 number. Prereq: Variable, given when topic is identified.

MSE 748 MASTER’S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.
MSE 740 DISSERTATION RESEARCH. (0) Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

MSE 768 RESIDENCE CREDIT FOR THE MASTER’S DEGREE. (1-6) May be repeated to a maximum of 12 hours.

MSE 769 RESIDENCE CREDIT FOR THE DOCTOR’S DEGREE. (0-12) May be repeated indefinitely.

MSE 771 SEMINAR. (0) Review of current literature in the field of metallurgical engineering and presentation of papers thereon. Presentation of talks on departmental research. Group and panel discussions. Required of all graduate students every semester. Lecture, one hour per week.

MSE 781 SPECIAL PROBLEMS, LITERATURE AND LABORATORY. (1-3) Literature research and planning of research programs; shop problems and technical writing, including a term paper, are required. Consultation and lecture by appointment. May be repeated to a maximum of nine credits.

MSE 782 SPECIAL PROBLEMS, LITERATURE AND LABORATORY. (3) A continuation of MSE 781. Laboratory, six hours; consultation and lecture by appointment. May be repeated to a maximum of nine credits.

MUC 150 CLASS INSTRUCTION IN PIANO. (1) A beginning course in the fundamentals of playing the piano. Lecture, two hours. Prereq: For music majors, other students by consent of instructor.

MUC 151 CLASS INSTRUCTION IN PIANO. (1) A beginning course in the fundamentals of playing the piano. For music majors; other students by consent of instructor. Lecture, two hours. Prereq: MUC 150.

MUC 152 CLASS INSTRUCTION IN PIANO. (1) A course in the fundamentals of playing the piano. For music majors; others by consent of instructor. Lecture, two hours. Prereq: MUC 151.

MUC 153 CLASS INSTRUCTION IN PIANO. (1) A course in the fundamentals of playing the piano. For music majors; others by consent of instructor. May be repeated to a maximum of two credits with consent of instructor. Instruction, two hours. Prereq: MUC 152.

MUC 155 VOICE CLASS FOR NON-MUSIC MAJORS. (1) Applied voice group instruction for non-music majors with emphasis on basic breathing and vocal technique; elements of music notation, and diction. May be repeated to a maximum of two credits. Laboratory, two hours per week. Prereq: Consent of instructor.

MUC 157 CLASS INSTRUCTION IN PERCUSSION INSTRUMENTS. (1) A beginning course in the fundamentals of playing and teaching percussion instruments. Instruction, three hours. Prereq: For music majors only; others by consent of instructor.

MUC 158 CLASS INSTRUCTION IN WOODWIND INSTRUMENTS. (1) A beginning course in the fundamentals of playing and teaching woodwind instruments. May be repeated to a maximum of two credits. Prereq: For music majors; others by consent of instructor.

MUC 161 CLASS INSTRUCTION IN STRING INSTRUMENTS. (1) A beginning course in the fundamentals of playing and teaching violin, viola, cello and string bass. May be repeated to a maximum of two credits. Prereq: For music majors; others by permission of instructor. For nonstring majors who take this course for two semesters, it must be taken sequentially beginning in the fall semester.

MUC 163 CLASS INSTRUCTION IN BRASS INSTRUMENTS. (1) A beginning course in the fundamentals of playing and teaching brass instruments. Lecture, three hours per week. May be repeated to a maximum of two credits. Prereq: For music majors; others by consent of instructor.

MUC 164 CLASS INSTRUCTION IN GUITAR. (1) A beginning course in the fundamentals of playing the folk guitar. For nonmusic majors, music majors, or classroom teachers. Two hours laboratory per week. May be repeated to a maximum of two credits. Prereq: Consent of instructor.

MUC 265 VOICE CLASS FOR THEATRE MAJORS. (1) Applied voice group instruction with emphasis on vocal preparation for musical theatre performance. Elements of music notation. Two hours laboratory per week. May be repeated to a maximum of two credits. Prereq: Consent of instructor.

MUC 374 JAZZ PIANO. (2) A study of the basic elements of jazz piano with reference to its use in improvisation. Topics of concentration will include listening, analysis, and practical keyboard application, in addition to a study of the historical perspective and important styles. Prereq: MUS 272 and MUS 273, or consent of instructor.

CHAMBER MUSIC ENSEMBLES

MUC 170 STRING ENSEMBLE. (1) The study of string instrument chamber music through performance. May be repeated to a maximum of eight credits. Laboratory, two hours. Prereq: Consent of instructor.

MUC 171 BRASS ENSEMBLE. (1) The study of brass instrument chamber music through performance. May be repeated to a maximum of eight credits. Laboratory, two hours. Prereq: Consent of instructor.

MUC 172 WOODWIND ENSEMBLE. (1) The study of woodwind instrument chamber music through performance. May be repeated to a maximum of eight credits. Laboratory, two hours. Prereq: Consent of instructor.

MUC 173 PERCUSSION ENSEMBLE. (1) The study of percussion instrument chamber music through performance. May be repeated to a maximum of eight credits. Laboratory, two hours. Prereq: Consent of instructor.

MUC 174 UNIVERSITY CHORALE. (1) An auditioned choral ensemble for the study of choral literature through performance. Class will meet for five hourly rehearsals per week. May be repeated to a maximum of eight credits. Prereq: Audition and consent of instructor.

MUC 176 PIANO ENSEMBLE. (1) Study of piano ensemble chamber music through performance. May be repeated to a maximum of eight credits. Laboratory, two hours. Prereq: Consent of instructor.

MUC 177 GUITAR ENSEMBLE. (1) The study of guitar ensemble music through performance. May be repeated to a maximum of eight credits. Laboratory, two hours. Prereq: Consent of instructor.

LARGE MUSICAL ORGANIZATIONS

MUC 175 JAZZ ENSEMBLE. (1) Study of jazz through performance. May be repeated to a maximum of eight credits. Laboratory, three hours. Prereq: Consent of instructor.

MUC 187 CONCERT BAND. (1) A large concert band primarily for the general student desiring continuation of instrumental music experience. Laboratory, three hours. May be repeated to a maximum of four credits. Prereq: Consent of instructor.

MUC 188 SYMPHONIC BAND. (1) A select band engaged in preparation and performance of a variety of music composed for this medium. May be repeated to a maximum of four credits. Laboratory, four hours. Prereq: Audition and consent of instructor.

MUC 189 WIND ENSEMBLE. (1) The University’s select band for performance of challenging literature in the wind repertoire. May be repeated to a maximum of four credits. Prereq: Audition and consent of instructor.

MUC 190 MARCHING BAND. (1) Preparation for and performance at University athletic functions, primarily football games. May be repeated to a maximum of four credits. Prereq: Audition and consent of instructor.

MUC 191 ORCHESTRA. (1) Students who have demonstrated the required ability are given an opportunity to study and perform standard orchestral literature. May be repeated seven times for a total of eight credits. Prereq: Audition and consent of instructor.
MUC 192 UNIVERSITY CHORISTERS.  (1)
Ordinarily for music majors only. Three one-hour meetings per week. May be repeated seven times for a total of eight credits. Prereq: Audition and consent of instructor.

MUC 196 OPERA WORKSHOP.  (1)
Study of the principles and techniques of opera production through class presentation of scenes and complete works. May be repeated to a maximum of four credits. Prereq: Consent of instructor.

MUC 570 ADVANCED CHAMBER MUSIC ENSEMBLE.  (1)
Study of chamber music through performance. May be repeated to a maximum of six credits. Laboratory, two hours. Prereq: Consent of instructor.

MUC 596 OPERA WORKSHOP.  (1-3)
Study of the principles and techniques of opera production and direction through class presentation of scenes and complete works. May be repeated to a maximum of six hours. Prereq: Consent of instructor.

MUC 675 JAZZ ENSEMBLE.  (1)
Study of jazz through performance. Laboratory, two hours per week. May be repeated to a maximum of six credits. Prereq: Audition and consent of instructor.

MUC 689 WIND ENSEMBLE.  (1)
The University’s select band for performance of challenging literature in the wind repertoire. Laboratory, three hours per week. May be repeated to a maximum of six credits. Prereq: Audition and consent of instructor.

MUC 691 ORCHESTRA.  (1)
Students who have demonstrated the required ability are given an opportunity to study and perform standard orchestral literature. Laboratory, five hours per week. May be repeated to a maximum of six credits. Prereq: Audition and consent of instructor.

MUC 692 UNIVERSITY CHORISTERS.  (1)
The course offers students the opportunity to learn and perform the best choral literature in the repertoire. Laboratory, three hours per week. May be repeated to a maximum of six credits. Prereq: Audition and consent of instructor.

MUP Music – Performance Courses

(SPECIAL FEE)

NOTE: Students enrolled in MUP courses for two or more credit hours may be required to attend performance classes as well as lessons. See individual course syllabus for more information.

Prereq: Satisfactory audition and/or approval of instructor.

Undergraduate Courses Numbered 100-499 (1-3) Graduate Courses Numbered 500 and above (1-4)
Piano
MUP 101, 201, 301, 401, 501, 601, 701
Voice
MUP 102, 202, 302, 402, 502, 602, 702
Organ
MUP 103, 203, 303, 403, 503, 603, 703
Violin
MUP 104, 204, 304, 404, 504, 604, 704
Viola
MUP 105, 205, 305, 405, 505, 605, 705
Cello
String Bass
MUP 107, 207, 307, 407, 507, 607
Flute
MUP 108, 208, 308, 408, 508, 608, 708
Oboe
MUP 109, 209, 309, 409, 509, 609, 709
Clarinet
MUP 110, 210, 310, 410, 510, 610, 710
Bassoon
MUP 111, 211, 311, 411, 511, 611, 711
Trumpet
MUP 112, 212, 312, 412, 512, 612, 712
French Horn
MUP 113, 213, 313, 413, 513, 613, 713
Trombone
MUP 114, 214, 314, 414, 514, 614, 714
Euphonium
MUP 115, 215, 315, 415, 515, 615
Tuba
MUP 116, 216, 316, 416, 516, 616, 716
Saxophone (alto)
MUP 117, 217, 317, 417, 517, 617, 717
Percussion
MUP 118, 218, 318, 418, 518, 618, 718
Harp*
MUP 119, 219, 319, 419, 519, 619
Harpichord
MUP 120, 220, 320, 420, 520, 620
English Horn
MUP 321, 521
Historical Instruments*
MUP 322, 422, 522, 622
Classical Guitar
MUP 123, 223, 323, 423, 523, 623

*Consult the School of Music before enrolling.

#MUP 330 VOCAL COACHING FOR SINGERS.  (1-3)
A course to prepare the vocal student for performance in concert, recital, and opera. Materials to be covered include style, performance practices, diction, interpretation, and audition preparation. Course will include preparation of operatic as well as art song literature. Repertoire suitable for the individual student will be assigned by the voice teacher and prepared in this course by the vocal coach only after the music has been technically prepared by student’s individual voice teacher. May be repeated to a maximum of six credits. Prereq: Permission of vocal instructor.

#MUP 430 VOCAL COACHING FOR SINGERS.  (1-3)
A course to prepare the vocal student for performance in concert, recital, and opera. Materials to be covered include style, performance practices, diction, interpretation, and audition preparation. Course will include preparation of operatic as well as art song literature. Repertoire suitable for the individual student will be assigned by the voice teacher and prepared in this course by the vocal coach only after the music has been technically prepared by student’s individual voice teacher. May be repeated to a maximum of six credits. Prereq: Permission of vocal instructor.

#MUP 530 VOCAL COACHING FOR SINGERS.  (1-3)
A course to prepare the vocal student for performance in concert, recital, and opera. Materials to be covered include style, performance practices, diction, interpretation, and audition preparation. Course will include preparation of operatic as well as art song literature appropriate to designated course level. May be repeated to a maximum of six credits. Prereq: Permission of vocal/opera instructors.

MUP 558 CONDUCTING.  (1-4)
Private instruction in advanced conducting. Prereq: MUS 358 or MUS 364 or MUS 365 or consent of instructor.

#MUP 630 VOCAL COACHING FOR SINGERS.  (1-3)
A course to prepare the vocal student for performance in concert, recital, and opera. Materials to be covered include style, performance practices, diction, interpretation, and audition preparation. Course will include preparation of operatic as well as art song literature appropriate to designated course level. May be repeated to a maximum of six credits. Prereq: Permission of vocal/opera instructors.
MUP 658 CONDUCTING. (1-4)
Private instruction in advanced conducting. Prereq: MUS 358 or MUS 364 or MUS 365, or consent of instructor.

#MUP 730 VOCAL COACHING FOR SINGERS. (1-3)
A course to prepare the vocal student for performance in concert, recital, and opera. Materials to be covered include style, performance practices, diction, interpretation, and audition preparation. Course will include preparation of operatic as well as art song literature appropriate to designated course level. This course may only be taken after all applied vocal lesson requirements have been met. Prereq: Permission of vocal/ opera instructors.

One-Hour Credit
The following may register for one-hour credit performance courses:

1) Music majors electing a secondary instrument or a major instrument credit by direction of the adviser to fulfill degree performance requirements.
2) Students from other divisions of the University desiring elective credit but only upon approval of the School of Music.

Students in one-hour credit performance courses for secondary instrument credit may be taught in studio groups of four or less. Each undergraduate one-hour course may be repeated twice for credit. Each graduate one-hour course may be repeated three times for credit.

Two-Hour Credit
The following may register for two-hour credit performance courses:

1) Music majors in the Music Education or B.A. in Music degree programs;
2) Music minors;
3) Graduate students by direction of the adviser.

Each undergraduate two-hour course may be repeated twice for credit. Each graduate two-hour course may be repeated three times for credit.

Three-Hour Credit
The following may register for three-hour credit performance courses:

1) Music majors in the B.M. or M.M. in performance degree programs;
2) D.M.A. students by direction of the adviser.

Each undergraduate three-hour course may be repeated twice for credit. Each graduate three-hour course may be repeated three times for credit. Not offered during the summer session.

Four-Hour Credit
Only graduate students in the music performance programs may register for four-hour courses. These courses are available only at the 600- and 700-levels. Doctoral students only may register for 700-level courses. Four-hour credit courses may be repeated three times for credit. Not offered during the summer session.

MUS 001 RECITAL ATTENDANCE. (0)
The course will consist of attendance at recitals. Each freshman and sophomore student must attend a minimum of 16 concerts per semester (for a total of four semesters), to be chosen from faculty recitals, senior or graduate recitals, concerts by UK ensembles, Tuesday night student recitals, Chamber Music series, Central Kentucky Concert and Lecture Association, and Gallery Series. One-hour lab per week. Grade: P or F.

MUS 100 INTRODUCTION TO MUSIC. (3)
A study of the elements of music as they apply to the listening experience; designed for the nonmusic major with no prior knowledge of music. Emphasis will be placed upon developing an awareness and understanding of musical styles from the Renaissance to the present. Music majors may not use this course to fulfill either General Studies, University Studies, or music history requirements.

MUS 120 FOREIGN LANGUAGE VOCAL DICTION. (1)
A study of diction factors in Italian, German, and French vocal music. Lecture, two hours. May be repeated to a maximum of three hours. Prereq: Consent of instructor.

MUS 140 MUSIC ACOUSTICS. (3)
An introduction to certain physical laws governing sound, sources of sound and mediums through which sound travels. Included are acoustical explanations of how musical instruments produce sounds and their characteristic timbres. (Same as PHY 140.)

MUS 170 THEORY I—ELEMENTARY AURAL THEORY. (2)
Development of aural responsiveness to all elements of music, and of sight-singing techniques as an aid to music comprehension and performance. Prereq: Satisfactory completion of Theory Placement Exam; prerequisite or concur: MUS 171.

MUS 171 THEORY I—ELEMENTARY WRITTEN THEORY. (2)
The acquisition of harmonic vocabulary and development of part-writing techniques, elementary counterpoint, free composition, and analysis. Prereq: Satisfactory completion of Theory Placement Examination.

MUS 172 THEORY I—ELEMENTARY AURAL THEORY. (2)
Development of aural responsiveness to all elements of music, and of sight-singing techniques as an aid to music comprehension and performance. Prereq: MUS 170; prerequisite or concur: MUS 173

MUS 173 THEORY I—ELEMENTARY WRITTEN THEORY. (2)
The continuation of the work of MUS 171. Lecture, three hours. Prereq: MUS 171.

MUS 174 THEORY FOR NONMUSIC MAJORS. (3)
An introduction to the basic materials of musical organization, focusing on music reading, rudiments of notation, pitch, scale, tonal, and rhythmic organization, melody construction, simple harmonic vocabulary, and beginning aural training. Individual composition and improvisation exercises are used to approach much of this material. Ability to read music is not a prerequisite.

MUS 201 MUSIC IN WESTERN CULTURE TO 1700. (3)
Music from Ancient Greece to the end of the 17th century, as seen against a background of artistic, cultural, religious, and political change in Western Europe. Music majors may not use this course to fulfill either the University Studies or music history requirements.

MUS 202 MUSIC IN WESTERN CULTURE, 1700-PRESENT. (3)
A survey of music from 1700 (Vivaldi, Bach, Handel) to the present, in the context of artistic, cultural, political, and social changes in the Western cultural community. Music majors may not use this course to fulfill either University Studies or degree requirements.

MUS 203 HISTORY OF MUSIC. (3)
A survey of the history of music from ancient times through the Renaissance (up to approximately 1600). Required of all music majors. Prereq: Music majors— sophomore standing; nonmusic majors—consent of instructor.

MUS 206 AMERICAN MUSIC. (3)
A history of music in America from c. 1620 to the present. Will require listening to recordings, reading the primary text and suggested readings in books, periodicals and documents. Students should become aware of important names, places, events and styles in music as well as important historical trends and movements.

MUS 220 SYMPHONIC MUSIC. (3)
A survey of the symphonic repertoire from the Classical through the Contemporary. Emphasis will include the development of listening skills and an awareness of musical styles. Music majors may not use this course to fulfill University Studies or degree requirements.

MUS 221 A SURVEY OF CHORAL MASTERWORKS: BAROQUE TO THE PRESENT. (3)
A survey of the choral genre, tracing its development from the 18th century to the present. Lectures will include structure and symbolism in choral music as well as directed listening with emphasis upon historical and structural analysis of the works studied. In addition, attendance at selected concerts is expected.

MUS 222 HISTORY AND SOCIOLOGY OF ROCK MUSIC. (3)
A listening survey course, with a chronological approach, covering the years 1950-present. Emphasis will be on both the music and the sociological climate reflected and advocated by the music.

MUS 260 TEACHING MUSIC IN THE ELEMENTARY GRADES I. (2)
Together with MUS 261, this course is designed to develop musicianship, skills, and techniques teachers need to direct musical activities effectively in the elementary classroom. Music fundamentals and teaching materials are introduced through active participation in musical activities. Focus is on the music education in the lower elementary grades. For nonmusic majors or classroom teachers. Lecture, one hour; laboratory, two hours per week.
MUS 261 TEACHING MUSIC IN THE ELEMENTARY GRADES II. (2) Continuation of MUS 260. Focus is on the music education in the upper elementary grades. This course must be taken immediately following completion of MUS 260. For nonmusic majors or classroom teachers. Lecture, one hour; laboratory, two hours per week. Prereq: MUS 260.

MUS 262 VOCAL MUSIC METHODS AND MATERIALS SEMINAR I. (2) Fundamentals of singing, posture, breathing, diction. Reading of choral literature suitable for the junior and senior high school chorus. Beginning conducting. Accompanying. Lecture, two hours; laboratory, one hour. Prereq: MUS 172, 173 or consent of instructor.

MUS 263 INSTRUMENTAL MUSIC METHODS AND MATERIALS SEMINAR I. (2) Study of the history and philosophy of music education in the public schools and a study of the methods and materials in teaching instrumental music in the elementary schools. Laboratory band and orchestra experience with secondary instruments. Observations in the public schools with emphasis on the elementary and junior high school levels. Lecture, two hours; laboratory, one hour. Prereq: MUS 172, 173 or consent of instructor.

MUS 264 VOCAL MUSIC METHODS AND MATERIALS SEMINAR II. (2) Warm-up exercises, vocalizing, sight-reading in the chorus. Vocal styles. Reading and conducting choral literature suitable for the junior and senior high school chorus. Analyzing vocal problems. The teenage voice, including the boy’s changing voice. Lecture, two hours; laboratory, one hour. Prereq: MUS 262.

MUS 265 INSTRUMENTAL MUSIC METHODS AND MATERIALS SEMINAR II. (2) A study of the organization and administration of the school instrumental program. Overview of methods and materials and the beginning of repertoire study for school band and orchestras. Continuation of observations and visitations. Continuation of laboratory band and orchestra experiences. Study of the fundamentals of conducting. Lecture, two hours; laboratory, one hour. Prereq: MUS 263.

MUS 270 THEORY II – AURAL THEORY. (2) Development of aural responsiveness to all elements of music, and of sight-singing techniques as an aid to music comprehension and performance. Prereq: MUS 172; prereq or concurs: MUS 271.


MUS 272 THEORY II – AURAL THEORY. (2) Development of aural responsiveness to all elements of music, and of sight-singing techniques as an aid to music comprehension and performance. Prereq: MUS 270; prereq or concurs: MUS 273.

MUS 273 THEORY II – WRITTEN THEORY. (2) The continuation of the work of MUS 271. Three class hours per week. Prereq: MUS 271.

MUS 300 HISTORY OF JAZZ. (3) A listening survey course covering the chronological evolution of jazz from its West African and European roots, through its germination in America, to the present. Emphasis will be on the various styles and functions of jazz, particularly as they have been affected by changing social-cultural patterns during the twentieth century.

MUS 301 APPALACHIAN MUSIC. (3) A survey of musical genre and styles in the Southern Appalachian region. Vocal and instrumental, sacred and secular materials will be covered, together with the interchanges between black and white contributions. Prereq: MUS 100 or consent of instructor.

MUS 302 HISTORY OF MUSIC. (3) A survey of the history of music from the Baroque through the Classical periods (approximately 1600-1827). Required of all music majors. Prereq: For music majors, junior standing; nonmusic majors, consent of instructor.

MUS 303 HISTORY OF MUSIC. (3) A survey of the history of music from the Romantic period to the present (approximately 1827 to the present). Required of all music majors. Prereq: Music majors, junior standing; nonmusic majors, consent of instructor.

#MUS 325 SHAKESPEARE AND MUSIC. (3) The study of music inspired by the plays of Shakespeare. Shakespeare’s use of music in his plays, and an overview of music in Elizabethan times. The course is designed for non-majors.

MUS 330 MUSIC IN THE WORLD (Subtitle required). (3) This course examines the music of a chosen country or region of the world. The study of the historical, stylistic, theoretical, and functional aspects of the music will be related to the socio-historical, philosophical and other cultural aspects of the people in that country or region. Prereq: Junior standing or permission of the instructor.

MUS 350 MUSIC EDUCATION WORKSHOP. (1-2) Intensive study of specialized methods and materials in one of the following areas of music education: elementary and general music; piano; orchestra; band; jazz or choral. May be repeated to a maximum of four credits. Prereq: Consent of instructor.

MUS 358 CONDUCTING I. (2) A study of the technique and practice of fundamentals of conducting. Prereq: Junior standing in music.

MUS 360 GENERAL MUSIC I. (3) A study of the philosophy, the curriculum, and the process involved in promoting musical development of children in the elementary, middle, and high school environment. A field experience is required. Prereq: MUS 360.

MUS 361 GENERAL MUSIC II. (3) Methods, materials and techniques of teaching general music with emphasis on activities for the early childhood and elementary children. A field experience is required. Prereq: MUS 360.


MUS 365 INSTRUMENTAL MUSIC METHODS AND MATERIALS SEMINAR IV. (2) A summary of the administrative procedure for the high school band and orchestra director. Advanced conducting with emphasis on rehearsal procedures using advanced music for the high school ensemble. Assignment to public school instrumental teacher for teaching participation. Lecture, two hours; laboratory, one hour. Prereq: MUS 263, 265, 363.

MUS 366 MARCHING BAND TECHNIQUES. (2) A study of contemporary marching band techniques, styles, and trends with emphasis on drill writing and arranging for the marching band. Two hours lecture per week; one hour laboratory per week. Prereq: Consent of instructor.


MUS 371 INSTRUMENTATION AND ARRANGING. (2) A basic course in instrumentation and arranging for typical school instrumental and vocal ensembles. Prereq: MUS 273.

MUS 372 MUSICAL ANALYSIS. (2) A study of musical style through structural, harmonic and melodic analyses. Prereq: MUS 273.

MUS 373 FUNDAMENTALS OF JAZZ THEORY. (2) A study of the basic theoretical elements of jazz with reference to their use in improvisation. Topics of study will include harmonic, rhythmic, and melodic structure, keyboard application, and a study of styles and improvisation. Prereq: MUS 272 and 273, or consent of instructor.
MUS 390 TOPICS IN MUSIC HISTORY (Subtitle required). (3) Studies of a specific composer, genre, school of composers, or a topic crossing the traditional boundaries of music history. May be repeated to a maximum of six credits when identified by different course subtitles. Prereq: MUS 203, 302, and 303, or consent of instructor.

MUS 395 INDEPENDENT WORK IN MUSIC. (1-3) May be repeated to a maximum of six credits. Prereq: Major in music and a standing of 3.0 or consent of instructor.

#MUS 400G MUSIC HISTORY REVIEW. Prereq: Provisional graduate standing.

MUS 470G REVIEW OF HARMONY. (1) A review of common practice diatonic and chromatic harmony, through written work and analysis. May not be used to satisfy major requirements for Bachelors degrees in the College of Fine Arts. Lecture, two hours per week. Prereq: Provisional graduate standing.

#MUS 471G REVIEW OF AURAL SKILLS. (1) A review and continued development of basic listening skills, and the ability to comprehend aural harmonic function within a tonal framework and musical structures, both micro-structures and macro-structures. May not be used to satisfy major requirements for Bachelors degrees in the College of Fine Arts. Lecture, two hours per week. Prereq: Provisional graduate standing.

MUS 500 MUSIC OF THE MIDDLE AGES. (3) The development of Western music through the 14th century. Prereq: MUS 203 or consent of instructor.

MUS 502 MUSIC OF THE BAROQUE ERA. (3) The history of vocal and instrumental music in the Baroque style from 1600 to 1750. Prereq: MUS 302 or consent of instructor.

MUS 503 MUSIC OF THE CLASSIC PERIOD. (3) The development of music in the Classic style from the early 18th century to 1800. Prereq: MUS 302 or consent of instructor.

MUS 504 MUSIC OF THE 19TH CENTURY. (3) A study of master works of music composed in the 19th century. Prereq: MUS 303 or consent of instructor.

MUS 505 MUSIC OF THE 20TH CENTURY. (3) A stylistic study of representative compositions of the 20th century. Prereq: MUS 303 or consent of instructor.

MUS 506 HISTORY OF AMERICAN MUSIC. (3) A study of music in America from Colonial times to ca. 1920. Prereq: MUS 302 and 303 or consent of instructor.

MUS 520 VOCAL SOLO LITERATURE. (3) A stylistic study of solo vocal music from the Baroque to the present. Prereq: MUS 302 and 303 or consent of instructor.

MUS 521 ORGAN LITERATURE. (3) A course of study designed to give the organ student a practical knowledge of the development of the organ, its construction, the standard literature, and teaching materials. Prereq: MUS 302 and 303 or consent of instructor.

MUS 522 PIANO LITERATURE TO 1830. (3) An historical and analytical study of music for piano to 1830, including discussion of the development of the instrument and the emergence of the idiomatic piano writing. Prereq: MUS 302 or consent of instructor.

MUS 523 PIANO LITERATURE SINCE 1830. (3) A historical and analytical study of music written for the piano from the inception of the Romantic period to the present, from the parallel perspectives of changes in the approach to the instrument and stylistic developments as they are reflected in piano writing. Prereq: MUS 303 or permission of instructor.

MUS 530 COLLEGIUM MUSICUM. (1-3) The study and realization of performance practices in music from antiquity to the present. The number of credits granted will be determined by the involvement of the student, varying from rehearsal/performance (normally one hour credit) to detailed musicological research (to three hours credit). May be repeated to a maximum of nine credits. Prereq: Consent of instructor including determination of credit hour(s) to be granted per semester.

MUS 540 APPLICATIONS OF MUSIC TECHNOLOGY. (3) Applications of music technology hardware and software, including but not limited to MIDI systems, sequencing, notation software, and MIDI code. Emphasis will be on use of technology as tools for creativity and productivity. Content will be continually updated. No prior computer or MIDI experience assumed; space preference given to music majors. Prereq: Nonmusic majors must obtain permission of instructor; ability to read music required.

MUS 550 TOPICS IN MUSIC EDUCATION (Subtitle required). (1-3) In-depth study of a designated topic, special issue, philosophy, or methodology of music education. May be repeated to a maximum of nine credits when identified by different course subtitles. Prereq: Junior standing in music.

MUS 560 ORFF SCHULWERK. (1-3) The study of the philosophy and the methodology of the Orff Schulwerk method through movement, discussion, performance, improvisation, composition, and demonstration. Number of credits awarded will depend on total number of hours of participation and the amount of work in musical arrangement, orchestration, and composition. May be repeated to a maximum of six credits. Prereq: Junior standing in music or approval of instructor.

MUS 561 ORFF CERTIFICATION: LEVEL I, II, OR III. (2) An intensive and systematic study of the philosophy and the methodology of the Orff Schulwerk method based on the curriculum recommended by the American Orff Schulwerk Association. The three main components are ensemble, recorder, and movement. Participants must demonstrate competency in orchestration, recorder, and performance in order to obtain certification. Lecture, two hours; laboratory, two hours per week. May be repeated in sequence to a maximum of six credits. Prereq: Junior standing in music or approval of instructor.

MUS 563 MUSIC IN EARLY CHILDHOOD. (3) A comprehensive study of the musical growth and development of preschool and early elementary school children. Application of research findings in child development and music education to designing the environment, learning materials, and musical activities for young children through lectures, class discussions, demonstrations, and field experiences in an early childhood laboratory. Lecture, two hours; laboratory, two hours per week. Prereq: MUS 261, or MUS 360 or approval of instructor.

MUS 566 PIANO PEDAGOGY. (3) Investigation of techniques and materials for teaching piano in groups and to individual students, both children and adults. Prereq: Consent of instructor.

MUS 570 ORCHESTRA. (2) This course includes a study of the individual instruments of the orchestra and band with practice in scoring for these instruments. Prereq: MUS 371.

MUS 571 ORCHESTRA. (2) A continuation of MUS 570. Prereq: MUS 570.

MUS 572 COUNTERPOINT. (3) A study of 16th century contrapuntal techniques and of contrapuntal influences in common-practice music. Prereq: MUS 273 or equivalent.

MUS 573 COUNTERPOINT. (3) A study of 18th century contrapuntal techniques and of contrapuntal influences in Romantic and 20th century music. Prereq: MUS 273 or equivalent.

MUS 574 COMPOSITION. (2) A basic course in original composition and orchestration. Prereq: MUS 371.

MUS 575 COMPOSITION. (2) A continuation of MUS 574. Prereq: MUS 574.

MUS 578 ANALYSIS AND STYLE SURVEY. (3) Studies in analytical terminology and methodology; survey of major stylistic practices of Western music. Prereq: MUS 372 or equivalent.

MUS 600 RESEARCH I. (3) A course designed to acquaint students with basic techniques and tools used in music education research.

MUS 601 FOUNDATIONS IN MUSIC EDUCATION. (3) An historical survey of thought concerning the place and significance of music in the education of the individual and the group.

MUS 618 RESEARCH METHODS. (3) A survey of basic research techniques and materials in musicology and theory. Prereq: A reading knowledge of French or German.
MUS 620 ADVANCED GERMAN VOCAL REPERTORY. (3)
An intensive study of the stylistic and interpretive characteristics of German solo vocal literature.

MUS 622 SYMPHONIC LITERATURE. (3)
An intensive study of orchestral literature from the classical period to the present. Prereq: Graduate standing in music or consent of instructor.

MUS 623 OPERA LITERATURE. (3)
The development of opera as an art form, and analysis of representative operas from various areas. Prereq: Graduate standing in music or consent of instructor.

MUS 624 CHAMBER MUSIC LITERATURE. (3)
An intensive study of the development of instrumental chamber music. Prereq: Graduate standing in music or consent of instructor.

MUS 630 BAROQUE PERFORMANCE PRACTICES. (3)
An introduction to the problems, methods, bibliography, and discography of performance practices of the Baroque era, with particular emphasis on vocal and instrumental music of France, Germany, and Italy. Prereq: MUS 502 or consent of instructor.

MUS 650 MUSIC EDUCATION WORKSHOP. (1-4)
Intensive study of advanced methods and materials in one of the following areas of music education: elementary and general music, the school orchestra, the school band, choral music. May be repeated once for a total of two, three or four credits.

MUS 660 ADVANCED MUSIC EDUCATION METHODS AND MATERIALS (Subtitle required). (3)
An in-depth study and analysis of the methodology and materials and their development in music education. May be repeated to a maximum of 12 credits when identified by different course subtitles. Prereq: Graduate standing or consent of instructor.

MUS 664 MUSIC AND SPECIAL LEARNERS. (3)
This course is directed toward developing competencies and understandings relating to non-music and music educational objectives in therapy and education. Prereq: Consent of instructor.

MUS 665 PHYSIOLOGY AND FUNCTIONING OF THE SINGING VOICE. (3)
Detailed study of vocal physiology and acoustics of the singing voice. Major historical sources and recent scientific research form the basis of the course. Designed for professional voice teachers and music educators who work with singers. Prior study of acoustics recommended.

MUS 667 MATERIALS, TECHNIQUES AND LITERATURE OF VOICE TRAINING. (3)
Survey of currently published books, anthologies, and other materials for voice teaching. Various approaches to teaching vocal technique will be examined; other pertinent literature explored. Prereq: MUS 665.

MUS 670 MUSICAL STYLE I. (3)
Concentrated study of stylistic aspects, and of analytical methodologies suited to these aspects, in music of antiquity through 1600. Prereq: MUS 578 or equivalent.

MUS 671 MUSICAL STYLE II. (3)
Concentrated study of stylistic aspects, and of analytical methodologies suited to these aspects, in music of the Baroque and Classical periods. Prereq: MUS 578 or equivalent.

MUS 672 MUSICAL STYLE III. (3)
Concentrated study of stylistic aspects, and of analytical methodologies suited to these aspects, in music from 1820 to Bartok, Stravinsky and Schoenberg. Prereq: MUS 578 or equivalent.

MUS 673 ADVANCED COMPOSITION. (2)
May be repeated to a maximum of six credits. Prereq: MUS 575.

MUS 674 PEDAGOGY OF THEORY. (3)
Examination of the resources and techniques of teaching undergraduate music theory (aural and written components). Extensive review of the textbook literature, study of the application of contrasting theoretical approaches, and the examination of relevant Computer Assisted Instruction materials. Requirements to include practice teaching and observation of undergraduate music theory classes (MUS 171-173; 271-273; 170-172; 270-272). Prereq: MUS 578 or equivalent.

MUS 676 ADVANCED ANALYTICAL TECHNIQUES. (3)
Study of the most significant approaches to music analysis of the 20th century, including Schenkerian analysis, Forte set theory, and others. Prereq: MUS 578 or equivalent.

MUS 677 CONTEMPORARY MUSIC IDIOMS. (3)
Survey, with intensive study of representative works, of musical trends since 1935. Prereq: MUS 578 or 671 or 672.

MUS 678 HISTORY OF THEORY. (3)
A survey of theoretical ideas from the Greeks through 19th century English and German theorists. Prereq: MUS 578 or equivalent.

MUS 680 BAND HISTORY AND LITERATURE. (3)
A study of the heritage of the wind band through its leaders and literature, from its earliest roots to the present, with emphasis on the period from 1950 to the present. Prereq: Consent of instructor.

MUS 681 ADVANCED REHEARSAL TECHNIQUES – BAND. (3)
The development of effective rehearsal skills in the secondary school and university band settings, with emphasis on performance orientation, the development of aural concepts and advanced rehearsal analysis and techniques. Prereq: MUS 365; teaching experience or permission of instructor.

MUS 684 ADVANCED STRING METHODS AND MATERIALS. (3)
The study of string pedagogy through historical perspectives as it relates to the individual instruments as well as to class instruction. Prereq: Graduate standing in music or approval of instructor.

MUS 690 TOPICS IN MUSICOLOGY (Subtitle required). (3)
Investigation of critical and historical problems in musicology: intensive study of a specific composer, genre, or school of composers. May be repeated to a maximum of six credits when identified by different course subtitles. Prereq: Graduate standing and consent of instructor.

#MUS 695 INDEPENDENT WORK IN MUSIC. (1-3)
Study of an individually selected topic relevant to a student’s academic development. For work in musicology, theory, music education, or vocal literature, students should enroll in the designated independent work courses listed separately. May be repeated to a maximum of six credits. Prereq: Graduate standing in music and consent of instructor.

MUS 700 MEDIEVAL NOTATION. (3)
The study and transcription of the notation of medieval music from the earliest plainsong sources to mannered notation of the late Ars Nova in Italy and France. Lecture, three hours; laboratory, one hour. Prereq: Consent of instructor.

MUS 701 RENAISSANCE NOTATION. (3)
Study and transcription of the notation of Renaissance polyphony from the time of the Burgundian school through Palestrina and contemporaries, and of the various keyboard and lute tablatures of the 16th and 17th centuries. Lecture, three hours; laboratory, one hour. Prereq: Consent of instructor.

MUS 702 SEMINAR IN MUSICOLOGY. (3)
Study and research in specific musicological problems. May be repeated to a maximum of nine hours. Prereq: Consent of instructor.

MUS 704 MUSIC TECHNOLOGIES. (3)
An introduction to the principles of musical sound combined with an introduction to synthesizers and computer applications in music. Prereq: Graduate standing in music.

MUS 705 RESEARCH II. (3)
A course designed to lead the student in music education to do experimental research in the area of music education. Prereq: MUS 600.

MUS 706 MUSIC LEARNING AND BEHAVIOR. (3)
This course is intended for graduate students in music education with the major focus of the class involved in learning behavioral principles, learning observational categories pertaining to classroom reinforcement and role playing and practicing techniques to be employed later in the classroom. Prereq: Graduate standing in music.

MUS 707 TESTS AND MEASUREMENTS IN MUSIC. (3)
This course is designed to provide students with knowledge in measurements and evaluation in the field of music education and research. Topics include principles of measurement, administration and evaluation of published standardized and teacher-made tests, interpretation of test results, and test construction. Prereq: MUS 600.

†MUS 718 DOCTORAL SEMINAR. (1-3)
May be repeated to a maximum of six hours. Prereq: Four to six hours of graduate credit in the area of specialization and consent of instructor.
MUS 748 MASTER’S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

MUS 749 DISSERTATION RESEARCH. (0)
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

MUS 750 ADMINISTRATION AND SUPERVISION OF PUBLIC SCHOOL MUSIC. (3)
A study of current trends in school music, curricula, testing programs, and other supervisory procedures.

MUS 762 MUSIC IN HIGHER EDUCATION. (3)
Historical and comparative studies in the teaching and administration of music in colleges and universities. Includes case studies in administration, music in European higher education and the relationship of music to all other elements of the academic program. Prereq: MUS 751.

MUS 766 SEMINAR IN MUSIC EDUCATION. (3)
Advanced professional study in the theory and practice of music education. May be repeated to a maximum of six credits. Prereq: Consent of instructor.

MUS 767 INDEPENDENT WORK IN MUSIC EDUCATION. (1-3)
May be repeated to a maximum of six hours. Prereq: Four to six hours of graduate credit in area of specialization and consent of instructor.

MUS 768 RESIDENCE CREDIT FOR THE MASTER’S DEGREE. (1-6)
May be repeated to a maximum of 12 hours.

MUS 769 RESIDENCE CREDIT FOR THE DOCTOR’S DEGREE. (0-12)
May be repeated indefinitely.

MUS 770 PSYCHOLOGY OF MUSIC. (3)
A study of the processes of musical thinking and the effects of music on human behavior.

MUS 772 SEMINAR IN THEORY. (3)
Individual and group study of theoretical problems and areas of inquiry. May be repeated to a maximum of nine credits. Prereq: Graduate standing in Theory, or consent of instructor.

MUS 780 DIRECTED RESEARCH IN VOCAL LITERATURE. (1-3)
Individual directed research. Elective course for master’s degree students. Required for doctoral voice majors; topics assigned at discretion of instructor in proportion to credits undertaken. May be repeated to a maximum of 12 credits. Prereq: MUS 618 and MUS 620 or permission of instructor.

MUS 799 INDEPENDENT WORK IN MUSIC THEORY. (1-3)
May be repeated to a maximum of six hours. Prereq: Four to six hours of credit in area of specialization and consent of instructor.