Department of Mathematics
The Ohio State University

2008-2009 Mathematics Courses

Course Number	Course Title
50	Pre-College Mathematics I
75	Pre-College Mathematics II
104	Basic College Mathematics
105	Fundamental Mathematics Concepts for Teachers I
106	Fundamental Mathematics Concepts for Teachers II
107	Topics in Mathematics for Elementary Teachers
108	Number and Algebraic Structures for Middle School Teachers
109	Geometry and Measurement for Middle School Teachers
110	Algebraic Thinking and Probability for Middle School Teachers
111	Concepts of Calculus for Middle School Teachers
116	Excursions in Mathematics
117	Survey of Calculus
130	Math Analysis for Business I
131	Mathematical Analysis for Business II
132	Mathematical Analysis for Business III
148	Algebra and Trigonometry and Their Applications
150	Elementary Functions
151	Calculus and Analytic Geometry
151A	Calculus and Analytic Geometry
152A	Calculus and Analytic Geometry
153A	Calculus and Analytic Geometry
254A	Calculus and Analytic Geometry
151L	Calculus for Biology and Medicine
152	Calculus and Analytic Geometry
152L	Calculus for Biology and Medicine
153	Calculus and Analytic Geometry
161	Accelerated Calculus with Analytic Geometry
162	Accelerated Calculus with Analytic Geometry
263	Accelerated Calculus with Analytic Geometry
161A	Accelerated Calculus with Analytic Geometry I
162A	Accelerated Calculus with Analytic Geometry II
263A	Accelerated Calculus with Analytic Geometry III
161H	Accelerated Calculus with Analytic Geometry

Course Number	Course Title
162H	Accelerated Calculus with Analytic Geometry
263H	Accelerated Calculus with Analytic Geometry
187H	Advanced Problem Solving
487H	Advanced Problem Solving
190H	Elementary Analysis I
191H	Elementary Analysis II
264H	Elementary Analysis III
254	Calculus and Analytic Geometry IV
255	Differential Equations and Their Applications
345	Foundations of Higher Mathematics
366	Discrete Mathematical Structures I
415.01	Ordinary and Partial Differential Equations
415.02	Ordinary and Partial Differential Equations
504	History of Mathematics
507	Advanced Geometry
512	Partial Differential Equations and Boundary Value Problems
513	Vector Analysis for Engineers
514	Complex Variables for Engineers
520H	Linear Algebra Differential Equations Complex Analysis
521H	Linear Algebra Differential Equations Complex Analysis
522H	Linear Algebra Differential Equations Complex Analysis
530	Probability
532	Mathematical Foundations of Actuarial Science
540H	Geometry and Calculus in Euclidean Spaces and on Manifolds I
541H	Geometry and Calculus in Euclidean Spaces and on Manifolds II
547	Introductory Analysis I
548	Introductory Analysis II
549	Introductory Analysis III
551	Vector Analysis
556	Differential Equations I
557	Differential Equations II
566	Discrete Mathematical Structures II
568	Introductory Linear Algebra I
571	Linear Algebra for Applications I
572	Linear Algebra for Applications II
573	Elementary Number Theory
575	Combinatorial Mathematics & Graph Theory
576H	Number Theory Through History I
577H	Number Theory Through History II
578	Discrete Mathematical Models

Course Number	Course Title
580	Algebra I
581	Algebra II
582	Algebra III
590H	Algebraic Structures I
591H	Algebraic Structures II
592H	Algebraic Structures III
594H	Rigorous Probability
601	Mathematical Principles in Science I
602	Mathematical Principles in Science II
603.02	Mathematical Principles in Science III
618	Theory of Interest
630	Actuarial Mathematics I
631	Actuarial Mathematics II
632	Actuarial Mathematics III
650	Principles of Mathematical Analysis
651	Introduction to Real Analysis I
652	Introduction to Real Analysis II
653	Introduction to Real Analysis III
655	Elementary Topology I
656	Elementary Topology II
657	Elementary Topology III
665	Modern Mathematical Methods in Relativity Theory I
666	Modern Mathematical Methods in Relativity Theory II
670	Algebra I
671	Algebra II
672	Algebra III
701	Mathematical Principles in Science III: Calculus of Variations & Tensor Calculus

Mathematics 050 **5 credits** **Pre-College Mathematics I**
Au, Wi, Sp, Su

Prerequisite:

Course Code T on Math Placement Test. Not open to students with credit for any higher numbered math course.

Catalog Description:

Arithmetic of fractions and decimals, basic algebra, graphing equations, geometry, exponents, applications of exponents, lines and slopes, area.

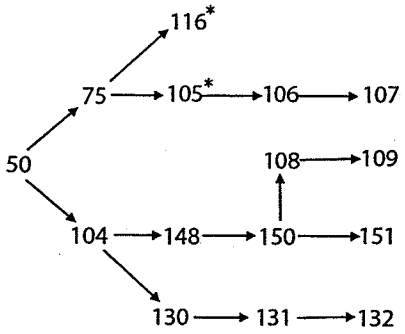
Purpose of Course:

Mathematics 050 is designed to meet the needs of the students entering The Ohio State University at the lowest placement, course code T. This course will prepare students for 075 or 104. Math conditions are removed by completion of 050 and 075 or 050 and 104.

Follow-up Course:

Math 075 or Math 104

Sequencing Chart:



*104 may serve as a prerequisite, but not recommened

Text:

Beginning Algebra (with applications) (7th ed.) by Aufmann, Barker, Lockwood (Houghton-Mifflin), Chapters 1 – 8 (omit Chapter 6 and Section 8.5).

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

1. Review of arithmetic, fractions, mixed numbers, decimals, exponential notation:

   The number line -- rational and real numbers.

   Properties of numbers:

prime factors	divisibility
order of operations	least common multiple
greatest common factor	distributive property
division algorithm	

   Arithmetic of signed numbers, properties of real numbers

   Exponents -- integral exponents and rational exponents (numerically)
   laws of exponents
   simplification of exponential expressions

   Note: Many of these topics are introduced at later points in the text, as needed for the corresponding development in algebra.

2. Problem solving with linear equations and inequalities:

   Solving linear equations, linear inequalities in one variable

   Applied problems and formulas:

cost, proportion, percent	compound interest
inequalities	geometric figures

3. Introduction to coordinate systems, ordered pairs, graphs of linear equations.

   Slope, intercepts, slope-intercept form, horizontal and vertical lines.

4. Polynomial arithmetic:

   Addition/subtraction, multiplication, division with remainder, factoring. Special products. Scientific notation.

5. Basic geometric figures; perimeters and areas:
   Triangles, circles, polygons.

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231 WEST EIGHTEENTH AVENUE
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Mathematics 075 **4 credits** **Pre-College Mathematics II**
Au, Wi, Sp, Su

Prerequisite:
Mathematics 050, or Course Code S on Math Placement Test. Not open to students with credit for any math course except 050.

Catalog Description:
Factoring, rational expressions and equations, graphs, systems of linear equations and inequalities, problem solving, roots and radicals, quadratic equations, complex numbers.

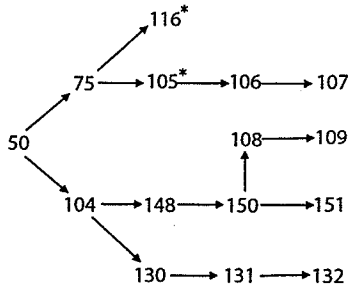
Purpose of Course:
To meet the needs of students entering the University with Course Code S on Math Placement Test, or with credit for 050. In addition, students placing at Course Code R and who need Math 130, must take 104 prior to enrolling in 130. Completion of Math 075 is required for entry into numerous degree granting colleges; however, credit for 075 will not count toward graduation in any degree granting program. It is designed for students continuing in Math 105 or 116.

Follow-up Courses:
Math 104 for students switching to science, computer science, business or engineering curriculum.

Math 105 for students intending to pursue MEd in early or middle childhood.

Math 116 for students in liberal arts or students in the precertification programs on regional campuses.

Sequencing Chart:



*104 may serve as a prerequisite, but not recommened

Text:
For Autumn 2008 only, Beginning Algebra, 4th Edition, by Elayn Martin-Gay, Prentice-Hall, ISBN 0131444441

New text for Winter 2009.

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List:

Sections	Topics
3.4–3.6	Graphing
	Slope and rate of change
	Slope-intercept form
	Point-slope form
4.1–4.4	Solving systems of linear equations
	Solving systems of linear equations by graphing
	Solving systems of linear equations by substitution
	Solving systems of linear equations by addition
	Systems of linear equations and problem solving
6.1–6.5	Factoring polynomials
	Greatest common factor and factoring by grouping
	Factoring trinomials
	Factoring trinomials
	Factoring binomials
	Solving quadratic equations by factoring
7.1–7.6	Rational expressions
	Simplifying rational expressions
	Multiplying and dividing rational expressions
	Adding and subtracting rational expressions
	Least common denominator
	Solving equations containing rational expressions
	Ratio and proportion
	Rational equations and problem solving
8.1–8.7	Roots and radicals
	Introduction to radicals
	Simplifying radicals
	Adding and subtracting radicals
	Multiplying and dividing radicals
	Solving equations containing radicals
	Radical equations and problem solving
	Rational exponents
9.1–9.3	Quadratic equations
	Solving quadratic equations by the square root method
	Solving quadratic equations by completing the square
	Solving quadratic equations by the quadratic formula

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231 WEST EIGHTEENTH AVENUE
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Mathematics 104 **5 credits** **Basic College Mathematics**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 050, or 075, or Course Code R on Math Placement Test. Not open to students with credit for 130 or 148 or 150 or 151.

Catalog Description:

Systems of equations, arithmetic of polynomials, rational expressions, factoring, fractional equations, inequalities, exponents, quadratic equations, absolute values, functions and graphs.

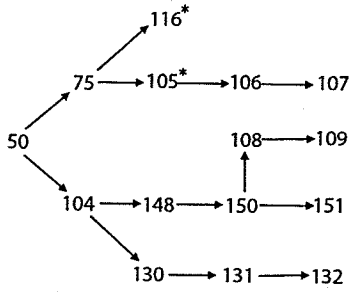
Purpose of Course:

To meet the needs of students entering the University with Course Code R or with credit for 050 who need to complete Math 130 or 148. Completion of Math 104 is required for entry into some degree granting colleges.

Follow-up Course:

Math 130 or 148

Sequencing Chart:



*104 may serve as a prerequisite, but not recommened.

Text:

Intermediate Algebra for The Ohio State University, by Hall/Mercer, McGraw-Hill, ISBN 0078060079 (with OSU custom Mathzone), or 0073304913 (with non custom Mathzone).

Alternate textbook: Intermediate Algebra, The Language and Symbolism of Mathematics, 1st edition, by Hall/Mercer, McGraw-Hill, ISBN 0072495829.

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List

Section	Topics
2.2	Functions and Representation of Functions
2.3/2.4	Linear Functions and Slope of a Line
2.5/2.6	Linear Equations, and Graphs of Linear and Absolute Value Functions
3.2	Solving Systems of Linear Equations in Two Variables Graphically and Numerically
3.3/3.4	Solving Systems of Linear Equations using the Substitution and Addition Method
3.5	More Applications of Linear Systems
4.1	Linear Inequalities in One Variable
4.2	Compound Inequalities
4.3	Absolute Values Equations and Inequalities

Review and Exam 1

5.4	An Introduction to Factoring
5.5	Factoring Trinomials
5.6	A General Strategy for Factoring Polynomials
5.7	Solving Equations by Factoring
6.1/6.2	Quadratic Functions, and Quadratic Equations and inequalities
6.3	Using the Quadratic Formula to Find Real Solutions
6.4	More Application of Quadratic Equations
6.5/6.6	Complex Numbers and Quadratic Equations with Complex Solutions

Review and Exam 2

7.1	Properties of Graphs of Rational Functions and Reducing Rational Expressions
7.2/7.3	Operations on Rational Expressions
7.4	Combining Operations and Simplifying Complex Rational Expressions
7.6	Equations Containing Rational Expressions
8.1	Evaluating Radical Expressions and Graphing Square Root and Cube Root Functions
8.2	Adding and Subtracting Radical Expressions
8.3	Multiplying and Dividing Radical Expressions
8.4	Equations Containing Radical Expressions
8.6	Rational Exponents and Radicals

Review and Exam 3

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Mathematics 105
Su, Au, Wi

5 credits

Fundamental Mathematics Concepts for Teachers I

**Currently taught in either lecture/recitation or workshop format.*

Prerequisite:
Mathematics 075 or 104, or Course Code L, M, N or R on Math Placement Test. Math 105N is open only to Rank 4 and GRD EDU students, and to students who have applied to the M. Ed. program.

Catalog Description:
Development of basic ideas of arithmetic as appropriate for elementary school teachers.

Purpose of Course:
To develop an appreciation of, and basic competency in, the use of analytical thought in the development of a cohesive body of useful mathematical knowledge, with special emphasis on topics encountered in elementary and middle school mathematics programs. Math 105 deals with the whole number system, integers, rational numbers, and combinatorial counting techniques.

Follow-up Course:
Math 106

Text:
Mathematics for Elementary Teachers, and Mathematics for Elementary Teachers: Activities Manual, 2nd Edition, (2008) by Sybilla Beckmann, Addison-Wesley, ISBN for the package is 0321447174

Topics List:
I. Problem solving
II. Numbers and the decimal system
III. Fractions
IV. Addition and subtraction
V. Multiplication
VI. Multiplication of fractions, decimals, and negative numbers
VII. Division

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 106 **5 credits** **Fundamental Mathematics**
Wi, Sp **Concepts for Teachers II**

**Currently taught in either lecture/recitation or workshop format.*

Prerequisite:

Mathematics 105 or written permission of the department. Math 106N is open only to Rank 4 and GRD EDU students, and to students who have applied to the M. Ed. program.

Catalog Description:

Continuation of Math 105. Development of basic ideas of geometry as appropriate for elementary school teachers.

Purpose of Course:

To develop an appreciation of, and basic competency in, the use of analytical thought in the development of a cohesive body of useful mathematical knowledge, with special emphasis on topics encountered in elementary and middle school mathematics programs. Math 106 introduces length, area, volume, angle, Euclidean geometry, congruent and similar triangles, symmetry and rigid motion, and knowledge of general spatial skills.

Follow-up Course:

Math 107

Text:

Mathematics for Elementary Teachers, and Mathematics for Elementary Teachers: Activities Manual, 2nd Edition, (2008) by Sybilla Beckmann, Addison-Wesley, ISBN for the package is 0321447174

Topics List:

I. Geometry
II. Geometry of motion and change
III. Measurement
IV. More about Area and volume

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 107 **5 cr.** **Topics in Mathematics**
Au, Sp **For Elementary Teachers**

**Currently taught in workshop format.*

Prerequisite:

Mathematics 106. Math 107N is open only to Rank 4 and GRD EDU students, and to students who have applied to the M. Ed. program.

Catalog Description:

Further topics in mathematics selected by the instructors to broaden the mathematical perspectives of elementary teachers.

Purpose of Course:

To develop an appreciation of, and basic competency in, the use of analytical thought in the development of a cohesive body of useful mathematical knowledge, with special emphasis on topics encountered in elementary and middle school mathematics programs. Math 107 deals with number theory, combinatorics, probability, early algebra, functions, graphs, sequences and series, and general mathematical skills.

Text:

Mathematics for Elementary Teachers, and Mathematics for Elementary Teachers: Activities Manual, 2nd Edition, (2008) by Sybilla Beckmann, Addison-Wesley, ISBN for the package is 0321447174

and supplemental materials provided in class.

Topics List:

I. Number Theory
II. Combinatorial Counting
III. Probability
IV. Functions and Algebra

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231 WEST EIGHTEENTH AVENUE
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Mathematics 108 **5 credits** **Number and Algebraic Structures for Middle School Teachers**
Au

Prerequisite:

Mathematics 150 or higher, or Math Placement Level L. Note: Open only to middle childhood majors.

Catalog Description:

Concepts of arithmetic, including number systems, binary operations, combinatorial counting, and number theory. Generalized algebraic structures developed through number systems, matrices, and modulo arithmetic.

Purpose of Course:

The purpose of the course is to prepare teachers of middle school students. In particular, it intends to deepen and extend the prospective teachers' content knowledge of the mathematics they will teach as well as their ability to reason with and communicate that knowledge.

Follow-up Course:

Mathematics 109

Text:

Algebra Connections: Mathematics for Middle School Teachers, by Ira Papick, Prentice Hall, 2007

Supplementary Text: Course Notes

Continued

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Topics List:

1. Number Systems
2. Addition and Subtraction
3. Multiplication and Division
4. Exponents and Roots/Logs
5. Combinatorial Counting
6. Number Theory
7. Divisibility
8. Algebraic Structures
9. Algebra of Matrices

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Mathematics 109
Wi

5 credits

Geometry and Measurement for Middle School Teachers

Prerequisite:

Mathematics 108. Note: Open only to middle childhood majors.

Catalog Description:

Geometrical concepts of definitions, postulates, congruence, similarity, coordinate geometry, transformations, and non-Euclidean geometry. Measurement concepts of units, conversion, irregular shapes, Pythagorean Theorem, and Cavalieri's Principle.

Purpose of Course:

The purpose of the course is to prepare teachers of middle school students. In particular, it intends to deepen and extend the prospective teachers' content knowledge of the mathematics they will teach as well as their ability to reason with and communicate that knowledge.

Follow-up Courses:

Statistics 145 and Mathematics 110

Text:

Geometry Connections (Prentice Hall Series in Mathematics for Middle School Teachers) by J.K. Beem, Prentice Hall, 2005.

Supplementary Text: Course Notes

Continued.

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Topics List:

1. Definitions and Euclidean postulates
2. Measurement
3. Congruence
4. Similarity
5. Coordinate geometry
6. Transformations of the plane
7. Transformations in Euclidean 2 and 3 dimensional space
8. Parallel postulate, introduction to non-Euclidean geometry

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231 WEST EIGHTEENTH AVENUE
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Mathematics 111 **5 credits** **Concepts of Calculus for Middle School Teachers**
Sp

Prerequisite:

Mathematics 148 or 150 and permission of Department.
Note: Open only to middle childhood majors.
Note: Not open to students with credit for 117, 131, 132, 151, or higher than 151.
Note: The prerequisite of Math 111 will be Math 150 and Math 110 when it will be regularly offered as a Winter Quarter course beginning in Winter 2010.

Catalog Description:

Language, representations, informal and formal calculations, and applications of instantaneous rates and accumulation through derivatives and integrals.

Purpose of Course:

The purpose of the course is to prepare teachers of middle school students. In particular, it intends to deepen and extend the prospective teachers' content knowledge of the mathematics they will teach as well as their ability to reason with and communicate that knowledge.

Follow-up Courses:

None currently. This course fulfills the calculus requirement for middle school mathematics teachers with a Mathematics Concentration. It will be followed up by Mathematics 212 when it will be regularly offered as a Winter Quarter course beginning in Winter 2010

Text:

Under Consideration
Supplementary Text: Course Notes

Continued.

Topics List:

1. Language and notation of rates and accumulation
2 Picturing rates and accumulation
3 Informally measuring rate
4 Precisely measuring rate
5 Informally measuring accumulation
6 Precisely measuring accumulation
7 Applications of differential calculus
8 Applications of integral calculus

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231 WEST EIGHTEENTH AVENUE
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Mathematics 116 **5 credits** **Excursions in Mathematics**
Au*, Wi, Sp, Su

*(*Offered in Autumn on regional campuses only.)*

Prerequisite:

Mathematics 075 or 076 or 104 or course code R on Math Placement Test.

Catalog Description:

Critical thinking and problem solving, with relevant topics met in everyday life; appropriate for majors in the non-physical sciences.

Purpose of Course:

The emphasis in this course is on intuitive understanding and developing some facility for applying mathematical ideas to problem solving.

Follow-up Courses:

None. Math 116 is a terminal course.

Text:

Excursions in Modern Mathematics, 6th edition, by Tannenbaum/Arnold, Prentice-Hall, ISBN 0131873636

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List chosen from the following:

Euler circuits
Graphs, Euler's theorem, Fleury's algorithm for an Euler circuit, Eulerizing graphs.

Traveling Salesman Problem
Hamilton circuits and paths, complete graphs, simple strategies for TSP, algorithms for approximate TSP solutions.

Networks
Trees, minimum spanning trees, Kruskal's algorithm for finding minimum spanning trees.

Voting
Preference ballots, five different methods of determining the winner of an election with 3 or more candidates.

Apportionment
Some U.S. history on congressional districts, basic concepts, Hamilton's method, quota rule, Alabama paradox, other methods.

Spiral growth in nature
Fibonacci numbers, golden ratio, the equation $x^2 = x + 1$, gnomons, gnomonic growth.

Population growth
Population growth dynamics, exponential growth models, logistic growth models, linear growth models, simple and compound interest.

Counting
Counting principles, permutations and combinations.

Symmetry
Geometric symmetry, rigid motions, reflections, rotations, translations, glide reflections, patterns.

Probability
Binomial probability, Pascal's triangle, multiplication rule.

Labs:

Labs involving logarithms, similar triangles, and Moebius strips.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 117 **5 cr.** **Survey of Calculus**
Au, Wi, Sp

Prerequisite:

Mathematics 148, 150, Course Code L, or Permission from the Math Department

Catalog Description:

An introduction to differential and integral calculus.

Purpose of Course:

The majority of the audience is made up of Architecture majors (who will have already taken 148 and 150) for whom the course is a requirement. The intent of the course is to provide students with basic concepts and skills associated with calculus, along with the applications of the topic.

Follow-up Courses:

There are really no follow-up courses. To start any other mathematics sequence will probably involve beginning at an appropriate entry-level course. Students interested in further course work in mathematics should consult the mathematics counselors in 250 Mathematics Bldg.

Text:

Single Variable Calculus: Concepts and Contexts, 3rd edition, by James Stewart, Thomson, ISBN 0534410227.

Calculator:

A graphing calculator is required for this course. Most instructors will be familiar with the Texas Instrument TI-83 and TI-84. NOTE: The TI-89, TI-92, and any calculator that uses a Computer Algebra System are not allowed in this course.

Continued.

Topics List & Sample Syllabus:

Sections **Topics**

Chapter 2: Limits and Derivatives
- 2.1: The Tangent and Velocity Problems
- 2.2: The Limit of a Function
- 2.3: Calculating Limits using the Limit Laws
- 2.6: Tangents, Velocities, and Other Rates of Change
- 2.7: Derivatives
- 2.8: The Derivative as a Function
- 2.9: What does f' say about f?

Chapter 3: Differentiation Rules
- 3.1: Derivatives of Polynomial and Exponential Functions
- 3.2: The Product and Quotient Rules
- 3.3: Rates of Change in the Natural and Social Sciences
- 3.4: Derivatives of Trigonometric Functions
- 3.5: The Chain Rule
- 3.6: Derivatives of Inverse Trigonometric Functions
- 3.7: Derivatives of Logarithmic Functions
- 3.8: Linear Approximation and Differentials

Chapter 4: Applications of Differentiation
- 4.2: Maximum and Minimum Values
- 4.3: Derivatives and the Shapes of Curves
- 4.4: Graphing with Calculus and Calculators
- 4.6: Optimization Problems
- 4.9: Antiderivatives

Chapter 5: Integrals
- 5.1: Areas and Distances
- 5.2: The Definite Integral
- 5.3: Evaluating Definite Integrals
- 5.4: The Fundamental Theorem of Calculus
- 5.5: Integration by Substitution
- 5.8: Integration using Tables
- 5.9: Approximate Integration

Chapter 6: Applications of Integration
- 6.1: More about Areas
- 6.2: Volumes
- 6.3: Arc Length
- 6.4: Average Value of a Function
- 6.5: Applications in Physics and Engineering (e.g., Moments and Center of Mass, Hydrostatic Force)
- If Time: Surface Area of solids of revolution

Mathematics 130 **4 cr.** **Math Analysis for Business I**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 104, or Course Code M or N on Math Placement Test.

Catalog Description:

Equations, inequalities, absolute value, polynomial functions, matrices, applications to business.

Purpose of Course:

Math 130 is a pre-calculus course with a finance section slanted toward a business program. The applications are business related.

Follow-up Course:

Math 131

Text:

Mathematics of Finance, 2nd OSU custom edition, by Haeussler/Paul/Wood, Prentice-Hall, ISBN 0536461066

Alternate Text: Introductory Mathematical Analysis for Business, Economics & The Life and Social Sciences, 12th edition, by Haeussler/Paul/Wood, Prentice-Hall, ISBN 0132404222

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus:

Sections	Topics
0.7, 0.8, 1.1	Applications of Equations, Linear Equations
1.2, 1.3	Applications of Inequalities
2.1, 2.2, 2.5	Special Functions, Graphs in Rectangular Coordinates
3.1, 3.2	Lines, Applications, and Linear Functions
3.3, 3.4	Quadratic Functions, System of Linear Equations
3.5, 3.6	Nonlinear Systems, Applications of Systems of Equations
4.1	Exponential Functions
4.2, 4.3	Logarithmic Functions, Properties of Logarithms
4.4	Logarithmic and Exponential Equations
5.1, 5.2	Compound Interest, Present Value
5.4	Annuities
5.5	Loans and Amortization

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Mathematics 131 **4 cr.** **Mathematical Analysis for Business II**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 130 or 148 or 150, or Course Code L on Math Placement Test.

Catalog Description:

Differential calculus, limits, definition of derivative, calculation of derivatives, curve sketching, applications.

Purpose of Course:

Math 131 is designed to introduce students in the College of Business to limits and derivatives. The course is problem oriented with an emphasis on business applications.

Follow-up Course:

Math 132.

Text:

Introductory Mathematical Analysis, 2nd OSU custom edition, by Haeussler, Wood & Paul, Prentice-Hall, ISBN 0-536-46107-4.

Alternate Text: Introductory Mathematical Analysis for Business, Economics & the Life Sciences, 12th edition, by Haeussler, Paul & Wood, Prentice-Hall, ISBN 0-132-40422-2.

Technology:

All students are required to have a graphing calculator for this course. Most instructors will be familiar with the Texas Instrument TI-83 and TI-84. NOTE: The TI-89, TI-92, and any calculator that uses a Computer Algebra System are not allowed in this course.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Course Coordinator:
B. Husen
2008-2009

Topics List and Sample Syllabus:

Sections	Topics
10.1	Limits
10.2	Limits (cont.)
10.3	Continuity
10.4	Continuity Applied to Inequalities
11.1	The Derivative
11.2	Rules for Differentiation
11.3	The Derivative as a Rate of Change
11.4	Product and Quotient Rules
11.5	The Chain Rule and the Power Rule
12.1	Derivatives of Logarithmic Functions
12.2	Derivatives of the Exponential Functions
12.4	Implicit Differentiation
12.5	Logarithmic Differentiation
12.7	Higher Order Derivatives
13.1	Relative Extrema
13.2	Absolute Extrema on a Closed Interval
13.3	Concavity
13.4	Second Derivative Test
13.5	Asymptotes
13.6	Applied Maxima and Minima

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Course Coordinator:
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2008-2009

Mathematics 132 **5 cr.** **Mathematical Analysis for Business III**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 131 or 151

Catalog Description:

Integral calculus, indefinite integration, area and definite integrals, improper integrals, functions of several variables, maxima, and minima.

Purpose of Course:

Math 132 is designed to introduce students in the College of Business to integral and multivariable calculus. The course is problem oriented with emphasis on business applications.

Text:

Introductory Mathematical Analysis, 2nd OSU custom edition, by Haeussler/Paul/Wood, Prentice-Hall, ISBN 0536461074

Alternate Text: Introductory Mathematical Analysis for Business, Economics & The Life and Social Sciences, 12th edition, by Haeussler/Paul/Wood, Prentice-Hall, ISBN 0132404222

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

Topics	Sections
14.1	Differentials
14.2	The Indefinite Integral
14.3	Integration with Initial Conditions
14.4	More Integration Formulas
14.5	Techniques of Integration
Appendix D	Summation
14.6	The Definite Integral
14.7	The Fundamental Theorem of Calculus
14.8	Approximate Integration
14.9	Area
14.10	Area Between Curves
14.11	Consumer Surplus and Producers Surplus
15.3	Integration by Tables
15.5	Differential Equations
15.7	Improper Integrals
17.1	Functions of Several Variables
17.2	Partial Derivatives
17.3	Applications of Partial Derivatives
17.4	Implicit Partial Derivatives
17.5	Higher Order Partial Derivatives
17.7	Maxima and Minima for Functions of Two Variables
17.8	Lagrange Multipliers

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 148 **4 cr.** **Algebra and Trigonometry**
Au, Wi, Sp, Su **and Their Applications**

Prerequisite:

Mathematics 104, or Course Code N on Math Placement Test.

Catalog Description:

Applications from chemistry, physics, and biology involving linear and rational exponents, solving and graphing linear and quadratic equations, systems of equations, trigonometry of acute angles, vectors and exponential equations.

Purpose of Course:

To help students make the transition from abstract mathematics to concrete applications, while reinforcing the algebra and trigonometry skills needed to proceed with more advanced mathematics.

Follow-up Course:

Math 150 for those students needing to take Math 151.

Text:

Contemporary College Algebra and Trigonometry: A Graphing Approach, OSU Custom Edition, by Hungerford, Thomson, ISBN 0495839671

Technology:

All students are required to have a graphing calculator, TI-83 or TI-84.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

Sections	Topics
1.1	Graphs
1.2	Solving Equations Graphically Part 1: The Root Method
1.3	Solving Equations Graphically Part 2: The Intersection Method
2.1	First-Degree Equations and Applications
2.2	Quadratic Equations and Applications
2.3	Maximum and Minimum Applications
3.1	Functions
3.2	The Art of Estimating
5.1	Exponential Functions
5.2	Applications of Exponential Functions
5.3	Common and Natural Logarithm Functions
5.4	Properties of Logarithms
5.5	Algebraic Solutions of Exponential and Logarithmic Equations
6.1/6.2	Variation & Arc Length and Area of a Circular Sector
6.3	Geometry: Similar Triangles
9.1	Trigonometric Functions of Acute Angles
9.2	Applications of Right Triangle Trigonometry
9.3	The Law of Cosines
9.4	The Law of Sines

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 150 **5 cr.** **Elementary Functions**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 148, or Course Code M on Math Placement Test.

Catalog Description:

Inverse functions, logarithmic, exponential and trigonometric functions, and their graphs; complex numbers.

Purpose of Course:

To learn the basic aspects of the elementary functions (rational, exponential, logarithmic, and trigonometric). Most students in this course plan to take the regular calculus sequence.

Follow-up Course:

Math 151 or Math 117

Text:

Precalculus: Mathematics for Calculus, 5th OSU Custom Edition, by Stewart/Redlin/Watson, Thomson, ISBN 0495420840.

Alternate Textbook: Precalculus: Mathematics for Calculus, 5th edition, by Stewart/Redlin/Watson, Thomson, ISBN 0534492770.

Technology:

All students are required to have a graphing calculator. Most instructors will be familiar with the Texas Instruments TI-83 and TI-84.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

Sections	Topics
2.1	What is a Function?
2.2	Graphs of Functions
2.3	Increasing and Decreasing Functions; Average Rate of Change
2.4	Transformations of Functions
2.5	Quadratic Functions; Maxima and Minima
2.6	Modeling with Functions
2.7	Combining Functions
2.8	One-to-One Functions and Their Inverses
3.1	Polynomial Functions and Their Graphs
3.4	Complex Numbers
3.5	Complex Zeros and the Fundamental Theorem of Algebra
3.6	Rational Functions
3.7	Polynomial and Rational Inequalities
4.1	Exponential Functions
4.2	Logarithmic Functions
4.3	Laws of Logarithms
4.4	Exponential and Logarithmic Equations
4.5	Modeling with Exponential and Logarithmic Functions
5.1	Angle Measure
5.2	Trigonometry of Right Triangles
6.1	The Unit Circle
6.2	Trigonometric Functions of Real Numbers
6.3	Trigonometric Graphs
6.4	More Trigonometric Graphs
7.1	Trigonometric Identities
7.2	Addition and Subtraction Formulas
7.3	Double-Angle, Half-Angle, and Sum-Product Formulas
7.4	Inverse Trigonometric Functions
7.5	Trigonometric Equations
8.3	Polar Form of Complex Numbers; DeMoivre's Theorem

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 151 **5 cr.** **Calculus and Analytic Geometry**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 150 (with grade C- or better) or Course Code L on Math Placement Test.

Catalog Description:

Limits, continuity, derivatives, Mean Value theorem, extrema, curve sketching, related rates, differentiation of the trig, log, and exp functions.

Purpose of Course:

To provide students with a solid foundation in one-variable differential calculus.

Follow-up Course:

Math 152

Text:

Calculus: Early Transcendentals, Volume 1, 5th OSU custom edition, by Stewart (Thomson Brooks/Cole), ISBN 0495294888.

Alternate Text: Calculus: Early Transcendentals, 5th edition, by Stewart (Thomson Brooks/Cole), ISBN 0534393217.

Supplementary Text: Just-In-Time: Algebra and Trigonometry for Students of Calculus, 3rd edition, by G. Mueller, R.I. Brent (Addison Wesley), ISBN 0321269438

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus:

Sections	Topics
1.1 Representation of Functions	3.2 Products and Quotient Rule
1.2 Catalog of Essential Functions	3.3 Rates of Change
1.3 New Functions from Old Functions	3.4 Derivatives of Trigonometric Functions
1.5 Exponential Functions	3.5 Chain Rule
1.6 Inverse Functions and Logarithms	3.6 Implicit Differentiation
2.1 Tangent and Velocity Problems	3.7 Higher Derivatives
2.2 Limit of a Function	3.8 Derivatives of Logarithmic Functions
2.3 Calculating Limits, Limit Laws	3.10 Related Rates
2.5 Continuity	4.1 Maximum and Minimum Values
2.6 Limits at Infinity: Horizontal Asymptotes	4.2 Mean Value Theorem
2.7 Tangents Velocities, Rates of Change	4.3 Derivatives & Shapes of Graphs
2.8 Derivatives	4.5 Curve Sketching
2.9 Derivative as Function	4.7 Optimization Problems
3.1 Derivatives of Polynomials, Exponential Function	4.10 Antiderivatives

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 151A Au **5 credits Each** **Calculus and Analytic Geometry**
Mathematics 152A Wi
Mathematics 153A Sp
Mathematics 254A Au

Prerequisite:
The prerequisites are the same as those for 151, 152, 153, 254; e.g. for 151A the prerequisite is Math 150 (C- or better) or satisfactory score on the mathematics placement test.

Catalog Description:
The catalog descriptions are the same as those for 151, 152, 153, 254.

Purpose of Course:
To introduce students to one-variable calculus with an emphasis on understanding fundamental concepts and how to apply them in a variety of different contexts. Examples and problems are taken from diverse fields and use graphical and numerical, as well as analytical methods.

Follow-up Course:
After finishing 151A students should be encouraged to take Math 152A, 153A and 254A. Students should be able to switch between the "A" sequence and the traditional calculus sequence.

Text:
Calculus: Single & Multivariable E-Grade Combination with Student Solutions Manual & Syllabus, 4th Edition, by Hughes-Hallett/Gleason, et al., Wiley, ISBN 0471788201.

Topics List:

151A:

Section	Title
1.1	Functions & Change
1.2	Exponential Functions
1.3	New Functions From Old
1.4	Logarithmic Functions
1.5	Trigonometric Functions
1.6	Powers, Polynomials, & Rational Functions
1.7	Introduction to Continuity
1.8	Limits
2.1	How Do We Measure Speed?
2.2	The Derivative At A Point
2.3	The Derivative Function
2.4	Interpretations Of The Derivative
2.5	The Second Derivative
2.6	Differentiability
4.6	Rates & Related Rate

Section	Title
3.1	Powers & Polynomials
3.2	The Exponential Function
3.3	The Product & Quotient Rules
3.4	The Chain Rule
3.5	The Trigonometric Functions
3.6	The Chain Rule & Inverse Functions
3.7	Implicit Functions
3.9	Linear Approximation & The Derivative
3.10	Theorems About Differentiable Functions
4.1	Using First & Second Derivatives
4.2	Families of Curves
4.3	Optimization
4.4	Applications to Marginality
4.5	Optimization & Modeling

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

152A:

Section	Title
5.1	How Do We Measure Distance Traveled?
5.2	The Definite Integral
5.3	The Fundamental Theorem & Interpretations
5.4	Theorems About Definite Integrals
6.1	Antiderivatives Graphically & Numerically
6.2	Constructing Antiderivatives Analytically
6.3	Differential Equations
6.4	Second Fundamental Theorem Of Calculus
6.5	The Equations Of Motion
7.1	Integration By Substitution
7.2	Integration By Parts
7.3	Tables Of Integrals
7.3.1	Algebraic Identities & Trigonometric Substitutions
7.7	Improper Integrals
7.8	Comparison Of Improper Integrals
8.1	Areas &Volumes
8.2	Applications To Geometry
8.4	Density & Center Of Mass
8.5	Applications To Physics

153A:

Section	Title
9.1	Sequences
9.2	Geometric Series
9.3	Convergence of Series
9.4	Tests For Convergence
9.5	Power Series & Interval Of Convergence
10.1	Taylor Polynomials
10.2	Taylor Series
10.3	Finding & Using Taylor Series
10.4	The Error In Taylor Polynomial Approximations
12.1	Functions Of Two Variables
12.2	Graphs Of Functions Of Two Variables
12.3	Contour Diagrams
12.4	Linear Functions
12.5	Functions Of Three Variables
12.6	Limits & Continuity
13.1	Displacement Vectors
13.2	Vectors In General
13.3	The Dot Product
13.4	The Cross Product
17.1	Parameterized Curves
17.2	Motion, Velocity, & Acceleration

254A:

Section	Title
14.1	The Partial Derivative
14.2	Computing Partial Derivatives Algebraically
14.3	Local Linearity & The Differential
14.4	Gradients & Directional Derivatives In The Plane
14.5	Gradients & Directional Derivatives In Space
14.6	The Chain Rule
16.1	The Definite Integral Of A Function Of Two Variables
16.2	Iterated Integrals
16.3	Triple Integrals
16.4	Double Integrals In Polar Coordinates
16.5	Integrals In Cylindrical & Spherical Coordinates
17.3	Vector Fields
18.1	The Idea Of A Line Integral
18.2	Computing Line Integrals Over Parameterized Curves
18.3	Gradient Fields & Path-Independent Fields
18.4	Path-Dependent Vector Fields & Green's Theorem
19.1	The Idea Of A Flux Integral
19.2	Flux Integrals For Graphs, Cylinders, & Spheres
20.1	The Divergence Of A Vector Field
20.2	The Divergence Theorem
20.3	The Curl Of A Vector Field
20.4	Stokes' Theorem

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 151L **5 credits** **Calculus for Biology and Medicine**
Au

Prerequisite:

Mathematics 150 (with grade C- or above) or Course Code L on Math Placement Test.

Catalog Description:

Limits, continuity, derivatives, Mean Value Theorem, extrema, curve sketching, related rates, differentiation of the trig, log, and exponential functions.

Purpose of Course:

To provide students with a solid foundation in one-variable calculus, to model and analyze phenomena in the life sciences

Follow-up Course:

Math 152L

Text:

Calculus for Biology and Medicine, 2nd Edition, by Claudia Neuhauser, Prentice-Hall, ISBN 0130455164

Topics List & Sample Syllabus:

Chapter 1 (1-2 lectures)
1.2: Elementary functions
1.3: Graphing

Chapter 2: (1-2 lectures)
2.1.1: Exponential growth and decay
2.2.2: Sequences

Chapter 3: (4-5 lectures)
3.1: Limits
3.2: Continuity
3.3: Limits at infinity
3.4: The Sandwich Theorem and some trigonometric limits
3.5: Properties of continuous functions

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Chapter 4 (7-8 lectures)
4.1: Formal definition of the derivatives
4.2: The power rule, basic rules of differentiation, and derivatives of polynomials
4.3: The product and quotient rules, derivatives of rational and power functions
4.4: The chain rule, related rates, and higher derivatives
4.5: Derivatives of trigonometric functions
4.6: Derivatives of exponential functions
4.7: Derivatives of inverse and logarithmic functions
4.8: Approximation and local linearity

Chapter 5 (8-9 lectures, team projects will be assigned during this period)
5.1: Extrema and the Mean Value Theorem
5.2: Monotonicity and concavity
5.3: Extrema, inflection points, and graphing
5.4: Optimization
5.8: Anti-derivatives (optional)

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 152 **5 cr.** **Calculus and Analytic Geometry**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 151 (with grade of C- or better).

Catalog Description:

Integrals, area, fundamental theorems of calculus, logarithmic and exponential functions, trigonometric and inverse trigonometric functions, methods of integration, applications of integration, polar coordinates.

Purpose of Course:

To provide students with a solid foundation in one-variable integral calculus.

Follow-up Course:

Math 153

Text:

Calculus: Early Transcendentals, Volume 1, 5th OSU custom edition, by Stewart, Thomson, ISBN 0495294888.

Alternate Text: Calculus: Early Transcendentals, 5th edition, by Stewart, Thomson, ISBN 0534393217.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus

Sections	Topics
4.4	Indeterminate Forms and L'Hospital's Rule
5.1	Areas and Distances
5.2	The Definite Integral
5.3	The Fundamental Theorem of Calculus
5.4	Indefinite Integrals and the Net Change Theorem
5.5	The Substitution Rule
5.6	The Logarithm Defined as an Integral
6.1	Areas between Curves
6.2	Volumes
6.3	Volumes by Cylindrical Shells
6.4	Work
7.1	Integration by Parts
7.2	Trigonometric Integrals
7.3	Trigonometric Substitution
7.4	Integration of Rational Functions by Partial Fractions
7.8	Improper Integrals
8.1	Arc Length
8.2	Area of a Surface of Revolution
9.1	Modeling with Differential Equations
9.3	Separable Equations
9.4	Exponential Growth and Decay

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 152L **5 cr.** **Calculus for Biology and Medicine**
Wi

Prerequisite:

Mathematics 151L

Catalog Description:

Limits, continuity, derivatives, Mean Value Theorem, extrema, curve sketching, related rates, differentiation of the trig, log, and exponential functions.

Purpose of Course:

To provide students with a solid foundation in one-variable calculus, to model and analyze phenomena in the life sciences

Follow-up Course:

Math 294L

Text:

Calculus for Biology and Medicine, Claudia Neuhauser, Second Edition, Pearson Education, INC

Topics List & Sample Syllabus:

Section	Topic
6.1	The Area Problem, Riemann Integrals
6.2	Fundamental Theorem of Calculus, Antiderivatives and Indefinite Integrals
6.3	Applications of Integration – Areas, Cumulative Change, Average Values, Volume of a Solid, Rectification of Curves
7.1	The Substitution Rule for Indefinite Integrals
7.2	The Substitution Rule for Definite Integrals
7.3	Integration, Rational Function and Partial Fractions
7.4	Improper Integrals – Unbounded Intervals, Unbounded Integrand
7.5	Numerical Integration – Midpoint Rule, Trapezoidal Rule
7.6	Tables of Integrals
7.7	Taylor Approximation, Taylor Polynomials,
8.1	Solving Differential Equations – Pure Time, Autonomous, Allometric Growth

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 153 **5 cr.** **Calculus and Analytic Geometry**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 152 (C- or better) or 161 or H161.

Catalog Description:

Indeterminate forms, Taylor's formula, improper integrals, infinite series, parametric curves and vectors in the plane; vectors, curves, and surfaces in space.

Purpose of Course:

To provide students with a solid foundation in calculus covering such topics as infinite series, power series, Taylor theorem; planar curves; vectors, curves and surfaces in space.

Follow-up Course:

Math 254

Text:

Calculus: Early Transcendentals, Volume 2, OSU custom edition, by Stewart, Thomson, ISBN 0495416924

Alternate Text: Calculus: Early Transcendentals, 5th edition, by Stewart, Thomson, ISBN 0534393217

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics & Sample Syllabus:

Sections	Topics
10.1	Curves Defined by Parametric Equations
10.2	Calculus with Parametric Curves
10.3	Polar Coordinates
10.4	Areas and Lengths in Polar Coordinates
11.1	Sequences
11.2	Series
11.3	The Integral Test and Estimates of Sums
11.4	The Comparison Tests
11.5	Alternating Series
11.6	Absolute Convergence, and the Ratio and Root Tests
11.8	Power Series
11.9	Representations of Functions as Power Series
11.10	Taylor and MacLaurin Series
11.11	The Binomial Series
11.12	Applications of Taylor Polynomials
12.1	Three-Dimensional Coordinate Systems
12.2	Vectors
12.3	The Dot Product
12.4	The Cross Product
12.5	Equations of Lines and Planes
12.6	Cylinders and Quadric Surfaces
12.7	Cylindrical and Spherical Coordinates
13.1	Vector Functions and Space Curves
13.2	Derivatives and Integrals of Vector Functions
13.3	Arc Length and Curvature
13.4	Motion in Space: Velocity and Acceleration

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 161	**Au**	**5 cr. Each**	**Accelerated Calculus**
Mathematics 162	**Wi**		**with Analytic Geometry**
Mathematics 263	**Sp**		

Prerequisite:

Math 162: 161 or written permission of department.
Math 263: 162 or written permission of department.

Catalog Descriptions:

161: Functions, limits and continuity, derivatives, applications of the derivative, the integral, inverse functions, techniques of integration, applications of integration.

162: Improper integrals; polynomial approximations and Taylor's theorem; infinite sequences and series; tests for convergence, vectors, lines and planes.

263: Multivariable calculus (vector approach), line and surface integrals, vector differential operators.

Purpose of Course:

The three-course sequence, 161-162-263, is equivalent in content to the four-course sequence 151-152-153-254. This accelerated sequence is designed for able students who are willing to learn some of the topics outside of class. As taught since Autumn 1990, 161 serves as a substitute for 151 and 152, 162 as a substitute for 153, and 263 substitutes for 254.

Follow-up Course:

Courses in differential equations or linear algebra, possibly H520, if completed 345 concurrently with 263.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Text:

Calculus: Early Transcendentals, Volume 1, 5th OSU custom edition, by James Stewart, Thomson, ISBN 0495294888. Volume 2 for Math 162 and 163.

Alternate Text: Calculus: Early Transcendentals, 5th edition, by James Stewart, Thomson, ISBN 0534393217.

NOTE: The textbook for the Math 161 sequence and Math 151 sequence is the same. The text for the H161 sequence is different.

Topics:

161: Will assume mastery of the computational aspects of polynomial and trigonometric differentiation, and will concentrate on integral calculus of the polynomial, logarithmic, exponential, trigonometric and inverse trigonometric functions, integration techniques, and applications.

162: Sequences and series, power series, Taylor's theorem, convergence tests, vectors, dot and cross product, lines and planes.

263: Surfaces, cylindrical and spherical coordinates, partial derivatives, multiple integrals, line integrals, vector fields, Green's and Stokes' Theorems.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 161A Au
Mathematics 162A Wi
Mathematics 263A Sp

5 cr.

Accelerated Calculus with Analytic Geometry I, II, III

Prerequisite:

Students are individually chosen by the College of Engineering
Math 161A: Course code L placement and high school calculus.
Math 162A: 161A or written permission of department.
Math 263A: 162A or written permission of department.

Catalog Description:

161A:
Functions, limits and continuity, derivatives, applications of the derivative, L'Hopital's Rule, the integral, techniques of integration, applications of the integral.

162A: Improper integrals; infinite sequences and series; tests for convergence; polynomial approximations and Taylor's Theorem; vectors, lines and planes; curves and surfaces in three-space

263A:
Multivariable calculus, vector fields, line and surface integrals.

Purpose:

These classes are part of the College of Engineering's Honors (FEH) Program, (previously known as the Gateway Program), in which selected students study core topics for the engineering curriculum in an integrated format. They were officially renamed 161G, 162G, 263G in 97-98 and 161A, 162A, and 163A in 04-05.

Text:

Calculus/Early Transcendentals, Volumes 1 & 2, 5th Edition, by Stewart, Thomson, ISBN 05343932017.

Topics:

Generally, the first quarter is the equivalent of 151 and 152; the second quarter covers 153; and the third quarter covers 254, and some additional topics.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H161 Au
Mathematics H162 Wi
Mathematics H263 Sp

5 cr. Each

Accelerated Calculus with Analytic Geometry

Prerequisite:
H161 - Credit for Math 151, or satisfactory score on Department Qualifying Exam.
H162 - H161 with a grade of C or better or written permission of Honors Committee chair.
H263 - H162 with a grade of C or better or written permission of Honors Committee chair.

Catalog Description:
The catalog descriptions for H161, H162, and H163 are the same as those for 161, 162, and 263 (respectively) - see listing for those courses.
HOWEVER - these descriptions as currently listed in the University Bulletin are not correct; for a more accurate description of their content, see "Topics" section below.

Purpose of Course:
This sequence is the honors version of the accelerated calculus sequence 161,162, 263; it is *designed for students with credit for Math 151.* These courses are taught daily by faculty members in small classes with considerable student-teacher interaction. Students in this sequence will be held to higher standards of mathematical rigor than those in non-honors versions; they will be expected to demonstrate mastery of definitions and statements and proofs of theorems. Math H161 is a substitute for 151 and 152, H162 for 153, and H263 for 254.

Follow-up Course:
After completing H263 concurrently with 345, students will be ready for Math H520, H521 and H522 (or various other courses in linear algebra, analysis or differential equations).

Text:
Calculus with Analytic Geometry, 2nd edition, by Simmons, McGraw-Hill, ISBN 007057624
NOTE: The textbooks for the Math 161 sequence and Math 151 sequence are not the same as H161.

Topics:
H161. The concept of the limit, continuous functions, differentiation, the Mean Value Theorem, implicit functions, derivatives of higher orders, applications of derivatives, integral calculus of the polynomial, logarithmic, exponential and trigonometric functions, integration techniques and applications.
H162. L'Hospital's rule, improper integrals, sequences and series, convergence tests, power series, Taylor's formula, conic sections, polar coordinates and their applications, parametric equations of curves, vector algebra in the plane and three-dimensional space, derivatives of vector functions, curvature and the unit normal vector, tangential and normal components of acceleration, analytic geometry of three-dimensional space.
H263. Partial derivatives, the tangent plane to a surface, directional derivatives and the gradient, the chain rule for partial derivatives, maximum and minimum problems, Lagrange multipliers, multiple integrals and their applications, cylindrical and spherical coordinates, areas of surfaces, line and surface integrals, Green's theorem, Divergence theorem, Stokes' theorem.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H187 **2 cr. Each** **Advanced Problem Solving**
Mathematics H487
Au

Prerequisite:

Permission of Department.

Catalog Description:

An advanced enrichment course for interested and capable students.

Purpose of Course:

To offer an experience in problem solving in mathematics for interested and talented students beyond what they would encounter in a standard program. It is preparation for the National Putnam Mathematics Exam. This course is repeatable to a maximum of 6 credit hours, and is graded S/U. This course may not be counted in a major or minor program in Mathematics.

Topics:

Interesting special problems as chosen by the instructor.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H190	**Au**	**5 cr. Each**	**Elementary Analysis I**
Mathematics H191	**Wi**		**Elementary Analysis II**
Mathematics H264	**Sp**		**Elementary Analysis III**

Prerequisite:
H190 - Permission of department
H191 - A grade of C or better in H190
H264 - A grade of C or better in H191

Catalog Descriptions:
H190: The first of an enriched honors calculus sequence designed to introduce students to the mathematical underpinnings of analysis.

H191: Continuation of H190.

H264: Continuation of H191; a rigorous treatment of multivariable integrals including gradients, multiple integrals, line and surface integrals, Green's theorem, the divergence theorem, and Stokes' theorem.

Purpose of Course:
This three-quarter sequence comprises the most intensive first year honors track in mathematics. It is designed to challenge talented, highly motivated students, regardless of their chosen major area of study. The courses introduce students to the mathematical underpinnings of calculus and stimulate the development of mathematical thinking, in addition to covering the material of the traditional calculus sequence. This sequence will substitute for Math 151, 152, 153, 254, and 551. H190 - H191 fulfill the analysis requirement for a Math major. The sequence is taught by faculty members in small sections with considerable teacher-student interaction.

Follow-up Sequence:
Math H520, H521, H522

Texts vary, for example:
H190, H191: Calculus, 3rd edition, by Spivak, Publish or Perish, ISBN 0914098896
H264: Advanced Calculus, by Folland, Prentice-Hall, ISBN 0130652652
H264: Advanced Calculus of Several Variables, Edwards, Jr. (used Sp05)
H264: Vector Calculus, 4th edition, Marsden/Tromba (used Sp00, Sp03)
H264: Advanced Calculus, 3rd edition, Buck (used Sp02)

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Topics:

H190 - H191:

Properties of real numbers
Mathematical induction
Definition of integral
Integrals of polynomials and trigonometric functions.
Applications
Continuity, limits, derivatives and applications
Fundamental Theorem of Calculus and integration techniques
Taylor series
Sequences and series of numbers and functions
Uniform convergence
Power series
If time permits, some differential equations or complex-valued functions.

H264:

Multivariable calculus (vector approach)
Gradients
Multiple integrals
Line and surface integrals
Green's Theorem
Divergence theorem
Stokes' Theorem.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 254 **5 cr.** **Calculus and Analytic Geometry IV**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 153

Catalog Description:

Partial differentiation, Lagrange multipliers, multiple integrals, line integrals, and Green's Theorem.

Purpose of Course:

To provide students with a solid foundation in calculus.

Text:

Calculus: Early Transcendentals, Volume 2, 5th OSU custom edition, by James Stewart, Thomson, ISBN 0495416924.

Alternate Text: Calculus: Early Transcendentals, 5th edition, by James Stewart, Thomson, ISBN 0534393217.

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List & Sample Syllabus:

Week	Sections	Topics
1	14.1	Functions of Several Variables
	14.2	Limits and Continuity
	14.3	Partial Derivatives
2	14.4	Tangent Planes and Linear Approximations
	14.5	The Chain Rule
	14.6	Directional Derivatives and the Gradient Vector
3	14.7	Maximum and Minimum Values
	14.8	Lagrange Multipliers
	---	*Review
4	---	*Midterm 1
	15.1	Double Integrals over Rectangles
	15.2	Iterated Integrals
5	15.3	Double Integrals over General Regions
	15.4	Double Integrals in Polar Coordinates
	15.5	Applications of Double Integrals
6	15.6	Surface Area
	15.7	Triple Integrals
	15.8	Triple Integrals in Cylindrical and Spherical Coordinates
7	15.9	Change of Variables in Multiple Integrals
	---	*Review
	---	*Midterm 2
8	16.1	Vector Fields
	16.2	Line Integrals
	16.3	The Fundamental Theorem for Line Integrals
9	16.4	Green's Theorem
	16.5	Curl and Divergence
	16.6	Parametric Surfaces and Their Areas
10	---	*Review for final
		OR: 16.7-16.9 (Stokes' theorem, divergence theorem)

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 255 **Au, Wi, Sp, Su** **5 cr.** **Differential Equations and Their Applications**

Prerequisite:
Mathematics 254. Not open to students with credit for 415, or 556.

Catalog Description:
Basic concepts and methods in solving ordinary differential equations, first and second order, linear differential equations, series solutions, numerical methods, Laplace transforms, physical applications.

Purpose of Course:
This course is an introduction to the most basic concepts and methods in solving ordinary differential equations. The emphasis of this course is on problem solving. Upon completion of this course students should know some applications of ordinary differential equations in engineering, physics and some other branches of the sciences.

Text:
Math 255: Elementary Differential Equations and Boundary Value Problems, 7th OSU Custom Edition, by Boyce/DiPrima, Wiley, ISBN 0471655198

Topics List & Sample Syllabus:

Sections	Topics	Approximate Time
	Introduction	
1.1	Some Basic Mathematical Models; Direction Fields	2 lectures
1.2	Solutions of Some Differential Equations	
1.3	Classification of Differential Equations	
2.2	Separable Equations	
	First Order Differential Equations	
2.1	Linear Equations with Variable Coefficients	6 lectures
2.4	Differences Between Linear and Nonlinear Equations	
2.5	Autonomous Equations and Population Dynamics	
2.6	Exact Equations and Integrating Factors	
2.7	Numerical Approximations: Euler's Method	
2.8	The Existence and Uniqueness Theorem	
	Second Order Linear Equations	
3.1	Homogeneous Equations with Constant Coefficients	5 lectures
3.2	Fundamental Solutions of Linear Homogeneous Equations	
3.3	Linear Independence and the Wronskian	
3.4	Complex Roots of the Characteristic Equation	

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus, cont'd:

3.5	Repeated Roots; Reduction of Order	
3.6	Nonhomogeneous Equations; Method of Undetermined Coefficients	
3.7	Variation of Parameters	
	MIDTERM #1	
	Higher Order Linear Equations	
4.1	General Theory of *n*th Order Linear Equations	6 lectures
4.2	Homogeneous Equations with Constant Coefficients	
4.3	The Method of Undetermined Coefficients	
4.4	The Method of Variation of Parameters	
	Series Solutions of Second Order Linear Equations	
5.1	Review of Power Series	6 lectures
5.2	Series Solutions near an Ordinary Point, Part I	
5.3	Series Solutions near an Ordinary Point, Part II	
5.4	Regular Singular Points	
5.5	Euler Equations	
5.6	Series Solutions near a Regular Singular Point, Part I	
5.7	Series Solutions near a Regular Singular Point, Part II	
	MIDTERM #2	
	The Laplace Transform	
6.1	Definition of the Laplace Transform	5 lectures
6.2	Solution of Initial Value Problems	
6.3	Step Functions	
6.4	Differential Equations with Discontinuous Forcing Functions	
6.5	Impulse Functions	
6.6	The Convolution Integral	

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 345 **4 cr.** **Foundations of Higher Mathematics**
Au, Sp

Prerequisite:

Mathematics 254.

Catalog Description:

Designed to prepare students for higher mathematics: an introduction to logic, proof techniques, set theory, number theory, integers, real numbers.

Purpose of Course:

Math 345 is intended to teach students the language of mathematics, to teach them the role of definitions in mathematics, to teach them how to read and write simple proofs, and to provide them with a conceptual framework for the study of higher mathematics.

In calculus, students are expected mainly to learn and apply computational skills. In upper division math courses, especially in those that are aimed primarily at math majors, students need to be familiar with the concepts of proof and generalization. Math 345 is a transitional course intended to follow calculus (254 or 263) and precede introductory analysis (547), algebra (580), 507 and 573. Students may also find Math 345 helpful as preparation for probability (530), linear algebra (568 or 571), number theory (573), and combinatorial mathematics and graph theory (575).

Text:

The Fundamentals of Higher Mathematics, Falkner

Other useful references:

Theory and Problems of Set Theory and Related Topics (Schaum's Outline), Lipschutz.
How to Read and Do Proofs, Solow.
The Foundations of Mathematics, Stewart and Tall.
Check out the "study tips" at www.math.ohio-state.edu/students

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 366 **3 cr.** **Discrete Mathematical Structures I**
Au, Wi, Sp, Su (1st Term)

Prerequisite:

Mathematics 132 or 152.

Catalog Description:

Mathematical formalization and reasoning, logic and Boolean algebra; sets, functions, relations, recursive definitions, and mathematical induction; and elementary counting techniques.

Purpose of Course:

To provide the foundation for a deeper understanding of the conceptual tools in computer science. Computers, however, are not used in this course. The desire of the CIS faculty is that the course presents math in rigorous form and requires students to deal with abstract systems and mathematical proofs.

Follow-up Course:

Math 566.

Text:

Discrete Mathematics with Applications, 3rd edition, by S. S. Epp, Thomson, ISBN 0534359450

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus:

Sections	Topics
	THE LOGIC OF COMPOUND SETS
1.1	Logical Form and Logical consequence
1.2	Conditional Statements
1.3	Valid and Invalid Arguments
1.4	Application: Digital Logic Circuits
	THE LOGIC OF QUANTIFIED STATEMENTS
2.1	Introduction to Predicates and Quantified Statements I
2.2	Introduction to Predicates and Quantified Statements II
2.3	Statements Containing Multiple Quantifiers
2.4	Arguments with Quantified Statements
	ELEMENTARY NUMBER THEORY AND METHODS OF PROOF
3.1	Direct Proof and Counterexample I: Introduction
3.2	Direct Proof and Counterexample II: Rational Numbers
3.3	Direct Proof and Counterexample III: Divisibility
3.4	Direct Proof and Counterexample IV: Division into Cases and the Quotient-Remainder Theorem
3.5	Direct Proof and Counterexample V: Floor and Ceiling
3.6	Indirect Argument: Contradiction and Contraposition
	SEQUENCES AND MATHEMATICAL INDUCTION
4.1	Sequences
4.2	Mathematical Induction I
4.3	Mathematical Induction II
4.4	Strong Mathematical Induction and the Well-Ordering Principle
	SET THEORY
5.1	Basic Definitions of Set Theory
5.2	Properties of Sets
5.3	Disproofs, Algebraic Proofs and Boolean Algebras
	RELATIONS
10.1	Relations on Sets
	FUNCTIONS
7.1	Functions Defined on General Sets
7.2	One-to-One and Onto, Inverse Functions
7.4	Composition of Functions

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 415 **Au, Wi, Sp, Su** **4 cr.** **Ordinary and Partial Differential Equations**

Prerequisite:

Mathematics 254

Catalog Description:

Ordinary, partial, linear and nonlinear differential equations; Fourier series, boundary value problems; and Bessel functions.

Purpose of Course:

To master the standard techniques of elementary ordinary differential equations, Fourier series, and separation of variables in partial differential equations. It is a combination of 255 (Differential Equations) and 512 (Fourier Series and Boundary Value Problems).

Text:

Math 415: Elementary Differential Equations and Boundary Value Problems, 7th OSU Custom Edition, by Boyce/DiPrima, Wiley, ISBN 0471655198

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

Section	Topic
1.1.1.3	Introduction to differential equations, including some applications for motivation
2.1	Linear first order ordinary differential equations (ODEs) and integrating factors
2.2	Separable equations
2.3	Applications of linear equations
2.4	Bernoulli's equation: Differences between linear and nonlinear equations
2.5	Qualitative theory for solving nonlinear ODEs
2.6	Exact equations
3.1	Homogeneous equations with constant coefficients
	10 days
3.2, 3.3	Fundamental solutions, linear independence, Wronskian
3.4	Complex numbers and complex roots of the characteristic polynomial
3.5	Repeated real roots of the characteristic equation and the method of reduction order
3.6	Nonhomogeneous equations: method of undetermined coefficients
3.7 *	Nonhomogeneous equations: method of variation of parameters
3.8	Mechanical and electrical vibrations
3.9	Forced vibrations
5.1 *	Review of power series
5.2 *	Examples of series solutions near regular points
	7-10 days
10.1	Two-point boundary value problems
10.2	Fourier series,
10.3	Fourier convergence theorem
10.4	Fourier series for even and odd functions
10.5	Heat equation with zero boundary conditions
10.6	Heat equation with other boundary conditions
10.7	Wave equation and D'Alembert's solution
10.8	Laplace's equation
	8 days

* These sections can be omitted at the instructor's discretion.

Boyce and DiPrima need concrete motivation leading into Sections:

- 2.1 – 2.6
- 3.1 – 3.9
- 5.1 – 5.2
- 10.1 – 10.7

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 504 **5 cr.** **History of Mathematics**
Sp, Su

Prerequisite:

Mathematics 580 or 568 or 507, or permission of department.

Catalog Description:

Development of mathematics from primitive origins to present form; topics include: development of arithmetic, algebra, geometry, trigonometry, and calculus.

Purpose of Course:

This course is an introduction to the history of mathematics.
The course now has a two-fold purpose:

(i) Expose the students to the good mathematics of yesteryear (while placing the evolution of mathematics in a historical setting).

(ii) This course fulfills the spirit of the Third-Level Writing Course for math majors. Oral presentations, short essays, and a long final paper may be required.

Text:

Math Through The Ages, Expanded, by Berlinghoff/Gouvea, Oxton House & MAA, ISBN 0883857367.

Topics:

The topics will vary based on the instructors.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 507 **5 cr.** **Advanced Geometry**
Au, Wi

Prerequisite:

Mathematics H264 or 345 or GRAD standing.

Catalog Description:

Advanced topics from Euclidean Geometry.

Purpose of Course:

This course explores all the two-dimensional geometries of constant curvature, beginning with advanced topics in Euclidean geometry, then extensively treating spherical and hyperbolic geometry.

Text:
Math 507 course packet.

Optional Reference:

1) Clemens, H., and Clemens, M. Geometry for the Classroom. Springer Verlag.
2) McCleary, J. "Trigonometries." Amer. Math. Monthly 109(2002), 623-638.

Topics:

I. Review of Euclidean geometry (resurrect high school geometry as the unique complete, flat, 2-dimensional geometry)
II. Intuitive idea of Riemannian geometry (consider 2-dimensional geometries which are 'curved')
III. Hyperbolic geometry (a negatively curved, complete homogeneous, 2-dimensional geometry)
IV. Rigid motions in 2-dimensional geometries (enough of these is what makes the geometry 'homogeneous')
V. Transformations, linear algebra, linear fractional transformations
VI. Spherical geometry (a positively curved, complete homogeneous, 2-dimensional geometry)
VII. Return to Riemannian geometry (curved geometries of various dimensions)

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231 WEST EIGHTEENTH AVENUE
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Mathematics 512 **3 cr.** **Partial Differential Equations**
Au, Wi, Sp, Su (1st Term) **and Boundary Value Problems**

Prerequisite:

Mathematics 255 or 415.

Catalog Description:

Fourier series, orthogonality relations, vibrating string, steady state heat, Laplace transform, and applications.

Purpose of Course:

This course develops problem solving skills with little emphasis on theory. Derivation of the partial differential equations from the physical models is not necessary. Students should be able to solve the PDE's and ODE's and interpret the solution.

Text:

Partial Differential Equations with Fourier Series and Boundary Value Problems, 2nd Edition, by Asmar, Prentice-Hall, ISBN 0131480960.

Topics List & Sample Syllabus

Sections	Topics	Approximate Time
1.1-1.2	Introduction	10 days*
2.1-2.4, 2.6-2.7	Fourier Series	
2.6	Complex Form of Fourier Series (optional)	
2.7	Forced Oscillations	
3.1, 3.3-3.8	Partial Differential Equations**	12 days*
4.1, 4.4(optional)	Laplacian in Polar Coordinates	
4.1 and 5.1(optional)	Laplacian in Spherical Coordinates	
8.1-8.2	Laplace Transforms	
8.2	Application of Laplace Transform to PDE's (or other applications)	

*Including a test

**Only rectangular coordinates are required.

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231 WEST EIGHTEENTH AVENUE
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Mathematics 513 **3 cr.** **Vector Analysis for Engineers**
Au, Wi

Prerequisite:
Mathematics 254

Catalog Description:
Vector algebra, vector operators, line integrals, vector integral theorems, curvilinear coordinates; applications.

Purpose of Course:
A basic course designed to give familiarity with vector notation, vector operations, line and surface integrals and the main theorems of vector calculus.

Text:
Introduction to Vector Analysis, 7th edition, by Davis and Snider, Quant Systems, ISBN 0697160998.

Possible Alternative Texts:
Advanced Engineering Mathematics, Kreyszig, 8th edition
Div, Grad, Curl and All That, Schey; and Schaum's outline Vector Analysis

Continued.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus:

Sections	Topics	Approximate Time
1.1-1.13	Review vector algebra, geometry, Dot and cross products, lines and planes	4 days
1.15 *	Tensor notation	
2.1-2.3	Vector functions of one variable, arc length,	5 days
2.4 optional **	Velocity, acceleration, curvature	
2.5 *	Tensor notation	
3.1-3.6	Vector and scalar functions, Chain Rule, Divergence, gradient and curl, directional derivative, normals, tangent planes	4 days
4.1-4.4, 4.6-4.9,	Line integrals, potentials, surfaces, surface integrals, Green's Theorem, the Divergence Theorem, Stokes' Theorem, potentials, Applications	13 days

* Sections 1.15 and 2.5, on tensor notation, introduce the index notation, which, even through very useful to physicists and engineers, can be omitted at the discretion of the instructor.

** Section 2.4 lends itself to a quick, beautiful, and culturally important exemplar of inductive reasoning: the derivation of Newton's law of universal gravitation from Kepler's three laws. See e.g. http://www.math.ohio-state.edu/~gerlach/Newton

In light of this importance, it is recommended that the instructor present this derivation, even though it is unlikely to be part of a midterm exam.

Additional Topics (Instructor's Choice) Time Permitting:
This syllabus is based on the Davis and Snider text. This book is well written but very verbose, which can actually be of considerable benefit. It does not include any applied science applications from fluid mechanics or electricity and magnetism, for example. But that could be remedied by the responsible instructor.

(Or different text:
Using Kreyszig, cover Chapters 8 and 9. This text is too terse and must be augmented slightly. (e.g. using Schaum's Outline)

Each class should include some applied examples obtained from other textbooks.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 514 **3 credits** **Complex Variables for Engineers**
Sp

Prerequisite:

Mathematics 254

Catalog Description:

Introduction to complex variables, analytic functions, complex integral theorems, power series, residues, conformal mapping.

Purpose of Course:

This is a "skills" course. Subject matter is needed in Engineering courses. Some time on line integrals may be saved, and Green's Theorem may be used to get the Cauchy integral theorem, since these topics have been covered in Math 254.

Text:

Complex Variables and Applications, 7th edition, by Brown/Churchill, McGraw-Hill, ISBN 0072872527

Possible Alternative Text:

Advanced Engineering Math, 8th edition, by Kreyszig. Kreyszig contains much diverse material. It is an excellent reference for engineers on many topics in mathematics.

Continued.

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Sample Syllabus #1: (Based on Churchill)

Topics	Approximate Time (days)
Complex numbers, polar form	3
Analyticity, Cauchy-Riemann equations	3
Elementary functions	4
TEST	
Mapping by elementary functions	3
Cauchy integral theorem and consequences	5
TEST	
Power series	3
Residues, definite integrals	6

Sample Syllabus #2: (Based on Kreyszig - 2 tests and a final exam)

Topics	Approximate Time (days)
Complex analytic functions	9
Complex integrals	5
Power Series, Taylor and Laurent Series	4
Integration by residues	6
Conformal Mapping (omit 16.5)	4
Complex functions and potential theory: (if time permits and prior material is grasped)	

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H520	**Au**	**5 cr. Each**	**Linear Algebra**
Mathematics H521	**Wi**		**Differential Equations**
Mathematics H522	**Sp**		**Complex Analysis**

Prerequisites:

H520: H263 or H264
H521: H520
H522: H521
Or written permission of Honors Committee chairperson.

Catalog Descriptions:

H520: Vector spaces, linear transformations, systems of equations, determinants, eigenvalues, spectral theorem, Cayley-Hamilton theorem.
H521: Ordinary, linear and nonlinear differential equations, existence and uniqueness theorems, Fourier series, boundary value problems, systems, Laplace transforms, phase space, stability and periodic orbits.
H522: Analytic functions, Cauchy integral theory, residue calculus, series representations, conformal mapping.

Purpose of Course:

This three quarter sequence is the second year of the honors program in mathematics. It is designed to challenge talented, highly motivated students, regardless of their chosen major. This sequence substitutes for Math 568, Math 255 or 415, and Math 514 or 552; the level of rigor is higher than in any of these classes. It is taught by faculty members in small sections with considerable teacher-student interaction.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Texts:

Vary, for example:

Autumn: H520
Linear Algebra: An Introductory Approach, 4th Revised Edition, by Curtis, Springer-Verlag, ISBN 387909923 (used Au03-Au07)
Linear Algebra and Its Applications, by Strang (2000)

Winter: H521
An Introduction to Ordinary Differential Equations, by Coddington, Dover, ISBN 0486659429 (1999, 2002, 2003, 2007)
Differential equations with Applications & Historical Notes, 2nd Edition, by Simmons (2005)
Nonlinear Dynamics and Chaos, by Strogatz (2001)
Introduction to Linear Algebra and Differential Equations, by Dettman (2000)

Spring: H522
Elementary Theory of Analytic Functions of One or Several Complex Variables, by H. Cartan, Dover, ISBN 0486685438 (2007)
Complex Analysis, 2nd edition, by Bak-Newman (2001, 2005, 2006)
Silverman, Complex Analysis with Applications, by Silverman (2003)
Complex Variables: Harmonic and Analytic Functions, by Flanigan (1999)

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 530 **3 cr.** **Probability**
Au

Prerequisite:

Mathematics 254.

Catalog Description:

Combinatorial probability, random variables, independence, expectations, variance.

Purpose of Course:

To introduce students to the fundamentals of probability theory and to teach them how to apply these fundamentals to solve problems.

Text:

Probability, by Jim Pitman, Springer-Verlag, ISBN 0387979743.

Topics:

Sets
Probability
Counting
Random Variables
Independence and conditioning
Mean, variance
Limit theorems

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231 WEST EIGHTEENTH AVENUE
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Mathematics 532 **3 cr.** **Mathematical Foundations**
Sp **of Actuarial Science**

Prerequisite:

Mathematics 530 or Statistics 420 or Statistics 520, or permission of instructor.

Catalog Description:

Problem workshop for applications of calculus and probability to actuarial science and risk management.

Purpose of Course:

To introduce students to the syllabus for the Society of Actuaries/Casualty Actuarial Society Examination P. The course will contain a quick review of ideas from calculus and probability, an introduction to the ideas of risk management needed for the examination, and extensive problem solving. Most students will sit for Exam P in May.

Text:

Actex Study Manual, 2008 edition, by Broverman, Actex Publications, ISBN 1566985617.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H540 **5 cr.** **Geometry and Calculus in Euclidean Spaces and on Manifolds I**
Wi *(offered odd years)*

Prerequisite:

Mathematics H263 or H264, H520, H521, or permission of the instructor

Catalog Description:

The topology of n-dimensional Euclidean space, differentiation of vector-valued functions, inverse and implicit function theorems, Riemann and Lebesgue integration in n-dimensional Euclidean space.

Purpose of Course:

The sequence H540, H541 is meant to provide an introduction to differential geometry: the application of the tools of multivariable calculus to the study of manifolds, especially curves and surfaces.

Follow-up course:

Math H541.

Texts vary, for example:

Differential Geometry of Curves and Surfaces, DoCarmo, (used Wi03)
Elements of Differential Geometry, R. Milman and G. Rarker
Elementary Topics in Differential Geometry, Thorpe (used Wi05)
A First Course in Geometric Topology and Differential Geometry, E. Bloch (used Wi07)

Topics for H540-H541:

Geometry of curves, surfaces, and higher dimensional manifolds
Curvature
Geodesics
The Gauss Bonnet Theorem
Mapmaking
Riemannian metrics
Non-Euclidean geometries.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H541 **5 cr.** **Geometry and Calculus in Euclidean Spaces and on Manifolds II**
Sp *(offered odd years)*

Prerequisite:

Mathematics H540, or permission of the instructor

Catalog Description:

Curves and line integrals in n-dimensional Euclidean space, tensor and exterior algebras, differential forms, integration on manifolds, divergence and Stokes' theorem and applications.

Purpose of Course:

The sequence H540, H541 is meant to provide an introduction to differential geometry: the application of the tools of multivariable calculus to the study of manifolds, especially curves and surfaces.

Texts vary, for example:

Differential Geometry of Curves and Surfaces, DoCarmo, (used Sp03)
Elements of Differential Geometry, R. Milman and G. Rarker
Elementary Topics in Differential Geometry, Thorpe (used Sp05)
A First Course in Geometric Topology and Differential Geometry, E. Bloch (used Sp07)

Topics for H540-H541:

Geometry of curves, surfaces, and higher dimensional manifolds; curvature; geodesics; the Gauss Bonnet Theorem; mapmaking; Riemannian metrics; non-Euclidean geometries.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 547 **3 cr.** **Introductory Analysis I**
Au, Wi

Prerequisite:

Mathematics 345 or equivalent

Catalog Description:

547, 548, 549 is an integrated sequence in advanced calculus covering sequences, limits, continuous functions, differentiation, Riemann integral; infinite series, sequences and series of functions, Taylor series, improper integrals.

Purpose of Course:

547, 548, 549 is a sequence designed to develop analytic intuition and proof skills. Student participation is emphasized. One of the primary purposes of 547 is that the student gain experience with concrete estimates and inequalities.

Follow-up Course:

Math 548.

Text:

Introduction to Real Analysis, 3rd edition, by Bartle/Sherbert, Wiley, ISBN 0471321486

Topics:

1. Monotone functions. Monotone sequences.
2. Boundedness. Estimations.
3. Definition of the limit of a sequence. Limit rules. Standard examples.
4. Principle of nested intervals. The Bolzano-Weierstrass Theorem. The Cauchy Criterion. Supremum and infimum.
5. Infinite series. Comparison tests. Ratio and root tests. Integral test. Absolute convergence.

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THE OHIO STATE UNIVERSITY
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COLUMBUS, OHIO 43210-1174

Mathematics 548 **3 cr.** **Introductory Analysis II**
Wi, Sp

Prerequisite:

Mathematics 547

Catalog Description:

Continuation of 547.

Purpose of Course:

547, 548, 549 is a sequence designed to develop analytic intuition and proof skills. Student participation is emphasized.

Follow-up Course:

Math 549

Text:

Introduction to Real Analysis, 3rd edition, by Bartle/Sherbert, Wiley, ISBN 0471321486

Topics:

1. Conditionally convergent series. Alternating series. Rearrangements.
2. Power series.
3. Continuous functions.
4. Limits of functions.
5. Uniform continuity.
6. Definition of the derivative. Differentiation rules.
7. Mean-Value Theorem.
8. L'Hospital's Rules.
9. Convexity.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 549 **3 cr.** **Introductory Analysis III**
Au, Sp

Prerequisite:

Mathematics 548.

Catalog Description:

Continuation of 548; the Riemann-Stieltjes integral; an introduction to the calculus of several variables.

Purpose of Course:

547, 548, 549 is a sequence designed to develop analytic intuition and proof skills. Student participation is emphasized.

Text:

Introduction to Real Analysis, 3rd edition, by Bartle/Sherbert, Wiley, ISBN 0471321486.

Topics:

1. Taylor's Theorem.
2. Definition of the Riemann integral. A piecewise continuous function is Riemann integrable. Properties of the integral.
3. Fundamental Theorem of Calculus. Integration by parts and change of variable.
4. Exponential and logarithmic function.
5. Improper integrals.
6. Functional sequences and series.
7. Uniform convergence.
8. Power series and analytic functions.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 551 **5 cr.** **Vector Analysis**
Sp

Prerequisite:

Mathematics 254

Catalog Description:

Vector operations in three dimensions, vector operators, surface area, the theorems of Green and Stokes, the divergence theorem; applications.

Purpose of Course:

The course is designed to enable students to understand and use the techniques of vector analysis in 2 and 3-dimensional spaces. Applications to the geometry of curves and surfaces will be emphasized. This course is not open to students with credit for 513.

Text:

Vector Calculus, 2nd Edition, by Thomas H. Barr, Prentice-Hall, ISGN 0130880051

Topics:

Review of vectors (dot product, cross product), curves, gradient, curl, divergence, line integrals, surface integrals, the Divergence Theorem, Green's Theorem, Stokes' Theorem and applications of these theorems.

Any selection of topics made by the instructor should aim to leave enough time in the end to cover the divergence theorem and Stokes' theorem.

Continued

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Sections	Topics	Approximate Time
Chapter 1	Review of vectors (dot product and cross product), lines and planes Vector valued functions, derivatives	2 weeks
4.1 4.2	Gradient Divergence and curl	2 weeks
Chapter 5	Arc length, line integrals, surface area, Integrals	6 weeks
Chapter 6	Conservative vector fields, Green's Theorem, Divergence Theorem, Stokes' Theorem	

Other possible topics that could be included are curl and divergence in different coordinate systems e.g. spherical and cylindrical coordinates (from the book Vector Analysis, Davis/Snyder, Section 3.10).

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 566 **3 cr.** **Discrete Mathematical Structures II**
Au, Wi, Sp, Su (2nd Term)

Prerequisite:

Mathematics 366.

Catalog Description:

Algorithms, efficiency of algorithms; pigeonhole principle, combinatorial identities, inclusion-exclusion, generating functions; graphs, Euler tours, Hamiltonian cycles, isomorphism, planarity, colorings, algorithms on weighted graphs, and networks.

Purpose of Course:

Follow-up to Math 366. The desire of the CS&E faculty is for this course to present math in rigorous form and require students to deal with abstract systems and mathematical proofs.

Text:

Discrete Mathematics with Applications, 3rd Edition, by S. S. Epp, Thomson, ISBN 0534359450

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List and Sample Syllabus:

Sections	Topics
	COUNTING
6.1	Introduction
6.2	Possibility Trees and the Multiplication Rule
6.3	Counting Elements of Disjoint Sets: The Addition Rule
6.4	Counting Subsets of a set: Combinations
6.7	The Binomial Theorem
	FLOOR AND CEILING FUNCTIONS
3.5	Direct Proof and Counterexample V: Floor and Ceiling
	O-NOTATION
9.1	Real-Valued Functions of a Real Variable and Their Graphs
9.2	O, Omega and Theta Notations
9.3	Application: Efficiency of Algorithms I
9.4	Exponential and Logarithmic Functions: Graphs and Orders
HANDOUT: Summations	
	RECURSION
8.1	Recursively Defined Sequences
HANDOUT: Recurrence Relations and Orders of Growth.	
8.4	General Recursive Definitions
	RELATIONS
10.1	Relations on Sets
10.2	Reflexivity, Symmetry, and Transitivity
10.3	Equivalence Relations
10.5	Partial Order Relations
	GRAPHS AND TREES
11.1	Graphs: An Introduction
11.2	Paths and Circuits
11.3	Matrix Representations of Graphs
11.4	Isomorphisms of Graphs
11.5	Trees
11.6	Spanning Trees (omit discussion of Kruskal's algorithm and Prim's algorithm)
HANDOUT: Planar Graphs	
HANDOUT: Graph Coloring	

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 568 **3 cr.** **Introductory Linear Algebra I**
Au, Wi, Sp, Su (1st Term)

Prerequisite:

Mathematics 254. Not open to students with credit for 571.

Catalog Description:

The n-dimensional Euclidean space and its subspaces; matrices as mappings; matrix algebra; systems of equations; determinants; dot product; geometric interpretations.

Purpose of Course:

Math 568 is a concrete introduction to linear algebra for (mathematically unsophisticated) students who have completed a four-quarter Calculus sequence, and serves as their introduction to Mathematics as a deductive discipline. This being the case, proofs that are computational in nature, that provide a computation, procedure or algorithm that can be readily employed by such students, are strongly preferred. However, the text does have many True/False problems requiring brief (justification)/(counter-example), as well as concrete problems requiring an understanding of the machinery and results that have been developed. Such problems should be included regularly in homework assignments.

Follow-up Course:
None.

Text:
Linear Algebra: A Modern Introduction, 2nd Edition, by Poole, Brooks/Cole, ISBN 0534998453

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Sample Syllabus:

Chapter 1 Vectors (one week, review)
1.1 Geometry and Algebra of Vectors
1.2 Dot Product
1.3 Lines and Planes

Chapter 2 Systems of Linear Equations (1 ½ weeks)
2.1 Systems of Linear Equations
2.2 Solving Linear Systems
2.3 Spanning Sets and Linear Independence
2.4 One application (ad libitum)

Chapter 3 Matrices (2 weeks)
3.1 Matrix operations
3.2 Matrix algebra
3.3 Matrix inverse
3.5 Subspaces, basis, l dimension and rank
3.6 Linear transformations

Chapter 4 Eigenvalues and Eigenvectors (2 ½ weeks)
4.1 Intro to eigenvalues and eigenvectors
4.2 Determinants
4.3 Eigenvalues and eigenvectors of an nxn matrix
4.4 Similarity and Diagonalization
4.6 An application or two (ad libitum)

Chapter 5 Orthogonality (2 weeks)
5.1 Orthogonality in R^n
5.2 Complements and Projections
5.3 The Gram Schmidt Process
5.4 Symmetric Matrices
7.3 Least Squares Approximation
7.4 Singular Value Decomposition (if time permits)

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 571 **3 cr.** **Linear Algebra for Applications I**
Au, Wi, Sp, Su (1st Term)

Prerequisite:

Math 254. Not open to students with credit for 601.

Catalog Description:

Linear systems of equations; vector spaces, matrices, linear operators; inner products, projections and least squares, approximations of eigenvalue problems; applications.

Text:

Linear Algebra Labs with Matlab, Hill & Zitarelli, 3rd edition
Linear Algebra with Applications, S. Leon, 7th edition

Topics List:

The course combines theoretical linear algebra (Leon) with hands-on experience (Hill & Zitarelli, and the software package Matlab). All classes are held in a MacIntosh Lab. Chapters 1-3 and the first half of chapter 5 will be covered from Leon. No programming is required for this course.

Leon:

Sections	Topics
Chapter 1	Matrices and Systems of Equations
Chapter 2	Determinants
Chapter 3	Vector Spaces
Chapter 5 (5.1-5.4)	Orthogonality

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 572 | **3 cr.** | **Linear Algebra for Applications II**
Wi, Su (2nd Term)

Prerequisite:

Math 571 or written permission of the department.

Catalog Description:

The eigenvalue problem for inner product spaces, projections and least squares approximation; classification of operators and quadratic forms; applications.

Text:

Linear Algebra Labs with Matlab, Hill & Zitarelli, 3rd edition
Linear Algebra with Applications, S. Leon, 7th edition

Topics List:

This is a continuation of 571. Chapter 5 of Leon's book will be completed, and Chapters 4 and 6 are covered. There will be additional selected applications.

Leon:

Sections	Topics
Chapter 5	Orthonormal Sets (Sections 5.5-end of chapter)
Chapter 4	Linear Transformations
Chapter 6	Eigenvalues

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 573 **5 cr.** **Elementary Number Theory**
Sp *(offered odd numbered years)*

Prerequisite:

Mathematics H264 or 366 or 345 or Grad standing or permission of department.

Catalog Description:

Utilization of concrete examples to introduce concepts of modern algebra; prime numbers, congruences, Diophantine equations, elementary combinatorial analysis.

Purpose of Course:

To introduce students to concepts in elementary number theory which serve as important examples of more general notions in modern abstract algebra; to develop reasonable facility in proofs involving these concepts.

Text:

An Introduction to the Theory of Numbers, 3rd edition, Niven and Zuckerman (or equivalent)

Topics:

1. Divisibility properties of integers, primes, Euclidean algorithm, unique factorization, greatest common divisors, least common multiples.
2. Linear Diophantine equations.
3. Congruences, Euler's function, Euler-Fermat Theorem, primitive roots.
4. Linear congruences, Chinese Remainder Theorem, quadratic congruences, Quadratic Reciprocity Law.
5. Optional Topics: Pythagorean Triples, sums of squares, cryptography, elliptic curves, higher degree Diophantine equations.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 575 **5 cr.** **Combinatorial Mathematics & Graph Theory**
Wi, Sp *(offered even numbered years)*

Prerequisite:

Mathematics 568.

Catalog Description:

Some classical puzzles of recreational mathematics; matching theory, graph theory, network flows, and optimization; enumeration techniques; combinatorial designs and coding theory.

Purpose of Course:

The purpose of this course is to acquaint the student with some aspects and applications of modern combinatorial theory; in particular, to communicate the meaning of the word "combinatorial" and to develop the student's facility for dealing with discrete and essentially nonalgebraic mathematical problems. The primary emphasis is on theory, but numerous illustrations and applications are presented. In addition, much of the theory has developed in response to practical optimization problems of various kinds. The course is designed to serve both the prospective mathematics graduate student as well as the student with an interest in or need for combinatorial techniques and tools.

Text:

Introductory Combinatorics, (4th ed.), Richard A. Brualdi

Topics List:
Fundamental counting principles
Combinatorial identities
Binomial and multinomial coefficients
Partitions of integers and sets
Stirling numbers
Principle of inclusion-exculsion
The pigeonhole principle
Graphs
Edge- and vertex- colorings
Chromatic polynomials
Matchings
Latin squares
Finite projective planes
Block designs
Symmetric block designs.

Continued.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List - Cont.

What is Combinatorics?

Examples include perfect covers of chessboards, magic squares, the 4-color problem, 36 officers problem, shortest route problem

Permutations and Combinations

Two basic counting principles, permutations and combinations of sets, permutations and combinations of multisets

The Binomial Coefficients

Pascal's formula, the binomial theorem, identities, the multinomial theorem, Newton's binomial theorem

Matchings in Bipartite Graphs

General problem formulation, matchings, systems of distinct representatives

Introduction to Graph Theory

Basic properties, Eulerian trails, Hamilton chains and cycles, bipartite multigraphs, trees

More on Graph Theory

Chromatic number, plane and planar graphs, 5-color theorem

Recurrence Relations & Generating Functions

Some number sequences, linear homogeneous recurrence relations, non-homogeneous recurrence relations, generating functions, recurrences and generating functions, exponential generating functions

Special Counting Sequences

Difference sequences and Stirling numbers, partition numbers

Combinatorial Designs

Block designs, steiner triple system, latin squares

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H576 Wi* **5 cr. each** **Number Theory**
Mathematics H577 Sp* **Through History I, II**

**Offered even numbered years*

Prerequisite:

H576: H190, H191, and H520, or permission of the department.
H577: H576 or permission of the department.

Catalog Description:

H576:
The integrated honors sequence H576-H577 includes elementary analytic and algebraic number theory and traces its unifying role in development of mathematics through history.

H577:
Continuation of H576.

Purpose of Course:

The intention of this sequence is to present number theory, the "Queen of Mathematics" through its historical development. Being one of the oldest mathematical disciplines, number theory, in the course of its history, both benefited from and contributed to such major mathematical areas as geometry, algebra and analysis. These courses will be especially beneficial for honor students planning to pursue careers in mathematics, physics, computer science and education, but may be of interest to engineering students as well.

Texts:

Vary, for example:

An Introduction to the Theory of Numbers, G. Hardy and E. Wright
A Course in Number Theory, (2nd edition), H. Rose
An Introduction to the Theory of Numbers, I. Niven, H.S. Zukkerman, H.L. Montgomery
Number Theory: An Introduction to Mathematics, Parts A and B, by William A. Coppel, Springer-Velag.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Suggested Topics List:

H576:

1. Review of Egyptian and Mesopotamian Mathematics. Greek tradition. Three classical Greek problems (cube doubling, angle trisection, circle quadrature).

2. Famous irrationalities.

3. Continued fractions and applications thereof (quadratic surds, Pell's equation, Diophantine approximations, etc.)

4. More on diophantine approximation. Algebraic numbers. Liouville numbers. A glimpse into the Thue-Siegel-Roth Theorem.

5. Uniform distribution modulo one. Weyl criterion. Some important sequences. Pisot-Vijayaraghavan numbers. Formulation and discussion of Margulis' solution of Oppenheimer's conjecture.

6. Normal numbers. Champernoun's example. Almost every number is normal. Levy-Khinchine Theorem on normality of continued fractions.

H577:

1. Infinitude of primes. Euler's identity. Chebyshev's Theorem. Bertrand's Postulate. Dirichlet's Theorem on primes in progressions. Average rate of growth of classical number-theoretical functions.

2. Finite fields. Wedderburn's Theorem. Applications: Latin Squares and Cryptography.

3. Quadratic reciprocity.

4. Pythagorean triangles. Representation of integers as sums of squares. Quaternions, Cayley's octavas. Hurwitz' Theorem. Minkowski's geometry of numbers.

5. *p*-adic numbers, their construction and axiomatic characterization (Ostrowski's Theorem). Minkowski-Hasse principle.

6. Fermat's last theorem. Some easy cases. A glimpse into modern developments (elliptic curves, Mordell-Weil Theorem, etc.).

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 109 **5 credits** **Geometry**
Wi **and Measurement for**
Middle School Teachers

Prerequisite:

Mathematics 108. Note: Open only to middle childhood majors.

Catalog Description:

Geometrical concepts of definitions, postulates, congruence, similarity, coordinate geometry, transformations, and non-Euclidean geometry. Measurement concepts of units, conversion, irregular shapes, Pythagorean Theorem, and Cavalieri's Principle.

Purpose of Course:

The purpose of the course is to prepare teachers of middle school students. In particular, it intends to deepen and extend the prospective teachers' content knowledge of the mathematics they will teach as well as their ability to reason with and communicate that knowledge.

Follow-up Courses:

Statistics 145 and Mathematics 110

Text:

Geometry Connections (Prentice Hall Series in Mathematics for Middle School Teachers) by J.K. Beem, Prentice Hall, 2005.

Supplementary Text: Course Notes

Continued.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

1. Language and notation of rates and accumulation
2 Picturing rates and accumulation
3 Informally measuring rate
4 Precisely measuring rate
5 Informally measuring accumulation
6 Precisely measuring accumulation
7 Applications of differential calculus
8 Applications of integral calculus

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H576 Wi* **5 cr. each** **Number Theory**
Mathematics H577 Sp* **Through History I, II**

**Offered even numbered years*

Prerequisite:

H576: H190, H191, and H520, or permission of the department.
H577: H576 or permission of the department.

Catalog Description:

H576:
The integrated honors sequence H576-H577 includes elementary analytic and algebraic number theory and traces its unifying role in development of mathematics through history.

H577:
Continuation of H576.

Purpose of Course:

The intention of this sequence is to present number theory, the "Queen of Mathematics" through its historical development. Being one of the oldest mathematical disciplines, number theory, in the course of its history, both benefited from and contributed to such major mathematical areas as geometry, algebra and analysis. These courses will be especially beneficial for honor students planning to pursue careers in mathematics, physics, computer science and education, but may be of interest to engineering students as well.

Texts:

Vary, for example:

An Introduction to the Theory of Numbers, G. Hardy and E. Wright
A Course in Number Theory, (2nd edition), H. Rose
An Introduction to the Theory of Numbers, I. Niven, H.S. Zukkerman, H.L. Montgomery
Number Theory: An Introduction to Mathematics, Parts A and B, by William A. Coppel, Springer-Velag.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Suggested Topics List:

H576:

1. Review of Egyptian and Mesopotamian Mathematics. Greek tradition. Three classical Greek problems (cube doubling, angle trisection, circle quadrature).

2. Famous irrationalities.

3. Continued fractions and applications thereof (quadratic surds, Pell's equation, Diophantine approximations, etc.)

4. More on diophantine approximation. Algebraic numbers. Liouville numbers. A glimpse into the Thue-Siegel-Roth Theorem.

5. Uniform distribution modulo one. Weyl criterion. Some important sequences. Pisot-Vijayaraghavan numbers. Formulation and discussion of Margulis' solution of Oppenheimer's conjecture.

6. Normal numbers. Champernoun's example. Almost every number is normal. Levy-Khinchine Theorem on normality of continued fractions.

H577:

1. Infinitude of primes. Euler's identity. Chebyshev's Theorem. Bertrand's Postulate. Dirichlet's Theorem on primes in progressions. Average rate of growth of classical number-theoretical functions.

2. Finite fields. Wedderburn's Theorem. Applications: Latin Squares and Cryptography.

3. Quadratic reciprocity.

4. Pythagorean triangles. Representation of integers as sums of squares. Quaternions, Cayley's octavas. Hurwitz' Theorem. Minkowski's geometry of numbers.

5. *p*-adic numbers, their construction and axiomatic characterization (Ostrowski's Theorem). Minkowski-Hasse principle.

6. Fermat's last theorem. Some easy cases. A glimpse into modern developments (elliptic curves, Mordell-Weil Theorem, etc.).

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 578 **5 cr.** **Discrete Mathematical Models**
Sp

Prerequisite:

CS&E 201, 202, or 221, and Mathematics 568, and either Mathematics 530 or Statistics 427 or 420.

Catalog Description:

Analysis and solution of various applied problems using discrete mathematical models; methods used include graph theory, linear optimization, Markov chains and queues.

Purpose of Course:

1. To introduce the mathematical structures and develop the mathematics appropriate for discrete modeling.
2. To demonstrate and encourage use of computers in solving mathematical problems
3. To give students an experience with a real world application for which they can construct a model that can be used to explore possible solutions.
4. To apply mathematical concepts and techniques encountered in earlier courses in the context of discrete modeling in a way that brings a new vividness and interest to the ideas.

Text:

"Discrete Mathematics" (Second Edition) by Norman L Biggs.

Other References:

Discrete Dynamical Systems, Sandefur
Mathematical Modeling, Maki & Thompson
Applying Mathematics, Burghes, Huntly & McDonald
Computer Simulation, Nancy Roberts et al, Addison-Wesley
Applications of Linear Algebra, Anton & Rorres, Wiley
An Introduction to Mathematical Models, Olinick
A variety of different modules available through COMAP
A First Course in Mathematical Modeling, (Second Edition), Giordano, Weir & Fox, Brooks/Cole Publishing Company

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics:
This course can examine a number of different topics in which the tools of discrete mathematics are used in the development of mathematical models. Suggested topics:

1. Discrete deterministic models developed from numerical data.
2. Markov processes
3. Random processes and Monte Carlo simulation.
4. Graph theory, including shortest paths, minimum weight spanning trees, and job scheduling.
5. Network flows and the Ford-Fulkerson algorithm for maximum flow.
6. Additional modeling topics as time and the interests of the instructor permit.

As a pedagogical tool, assignment of a term project involving discrete modeling with class reports the last week of the quarter, is highly recommended.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 580	**Au, Wi**	**3 cr. Each**	**Algebra I**
Mathematics 581	**Wi, Sp**		**Algebra II**
Mathematics 582	**Sp, Au**		**Algebra III**

Prerequisite:

580: Mathematics 568 (may be taken concurrently with 580) and Mathematics 345.
581: Mathematics 580 or H590
582: Mathematics 581 or H591

Catalog Description:

The integrated algebra sequence 580, 581, 582 includes elementary number theory, group theory, vector spaces and linear transformations, field theory.

Purpose of Course:

The 580-581-582 sequence covers topics in the theory of polynomial equations, number theory, linear algebra, and algebraic structures in a unified and integrated way.

The principal goal of the sequence is to show how abstract algebraic structures and methods deepen and enrich our understanding of the basic structures and concepts of school mathematics- numbers and arithmetic, polynomial equations, congruence and symmetry, ruler and compass constructions.

Text:

Shapes, Numbers, and Polynomials, lecture notes by Ronald Solomon.

Topics:

580: Groups; Group actions and symmetry.

581: Rings and Polynomials; Number systems; Elementary Number Theory.

582: Field extensions; Introduction of Galois Theory.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H590	**Au**	**5 cr. Each**	**Algebraic Structures I**
Mathematics H591	**Wi**		**Algebraic Structures II**
Mathematics H592	**Sp**		**Algebraic Structures III**

Prerequisite:

H590: H520 with a grade of C or better, or written permission of Honors Committee Chair
H591: H590 with a grade of C or better, or written permission of Honors Committee Chair
H592: H591 with a grade of C or better, or written permission of Honors Committee Chair

Catalog Description:

Integers, congruence relations, structure preserving maps, topics from groups, rings, modules, vector spaces, fields. The sequence H590, H591, H592 substitutes for the sequence 580, 581, 582.

Text:

Vary, for example:
Abstract Algebra, 3rd Edition, by D. Dummit/R. Foote, Wiley, ISBN 0471433349 (2004-2007)
Algebra, by M. Artin
Topics in Algebra, by I. Herstein

Suggested Topics:

H590:

1. Integers, unique factorization; congruences, Euler function.
2. Groups, subgroups, homomorphisms and isomorphisms, normal subgroups, quotient groups, permutation groups, cyclic groups, Cauchy Theorems, Sylow's Theorems; direct products, fundamental theorem for finite Abelian group; G-sets.
3. Rings, subrings, ideals, morphisms, polynomial rings, prime and maximal ideals.

Continued.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

H591:

1. Commutative rings, factorization theory, Euclidean rings, principal ideal rings, unique factorization domains, Gauss' lemma; illustrations in the integers of quadratic number fields.
2. Modules over commutative rings, submodules, quotients and direct sums; fundamental theorem for modules over principal ideal domains.
3. Vector spaces (as a special case of modules); linear maps and matrices, canonical forms, dual spaces.
4. The theory of determinants.

H592:

1. Bilinear and quadratic forms; inner product and unitary spaces; principal axis theorem.
2. Fields, algebraic and transcendental (extensions), existence of closure (over countable fields), tests for polynomial irreducibility; normality, separability, field automorphisms.
3. Galois theory, the subgroup-subfield correspondence theorem, group theory interrelations; extensions of finite fields, cyclotomic extensions.
4. Solvable groups and solvability by radicals.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H594 **5 credits** **Rigorous Probability**
Au

Prerequisite:

Math H264

Catalog Description:

A rigorous honors course on probability theory with special attention to applications within and outside mathematics.

Purpose of Course:

The acquaintance with rigorous probability theory, its history and its multiple connections, will better prepare these high quality students for graduate studies and will help them get involved in research at earlier stages of their careers.

Suggested Texts:

Elementary Probability Theory with Stochastic Processes, Kai Lai Chung
Probability Theory - A Concise Course, Y. Rosanov
Heads and Tails. An Introduction to Limit Theorems in Probability, E. Lesigne
The Pleasures of Probability, Richard Isaac
Statistical Inference in Probability, Analysis and Number Theory, M. Kac.

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Mathematics 601 **3 cr.** **Mathematical Principles in Science I**
Au

Prerequisites:

Several quarters of mathematics at the 400-500 level, including Mathematics 568 or 571.

Catalog Description:

Linear algebra in finite dimensions, abstract vector spaces, linear transformations, fundamental subspaces, complex inner product spaces.

Purpose of Course:

To make available an updated advanced-undergraduate/graduate course sequence which accommodates the academic (mathematical) and scheduling needs of client departments as well as those of the mathematics department.

Follow-up Course:

Math 602

Text:

Linear Algebra and its Applications, 3rd Edition, by Strang, Harcourt, ISBN 0155510053 (chapter 5). However later editions are also okay.

Introduction to Linear Algebra, Johnson, Riess & Arnold, (chapter 4)

Website:
http://www.math.ohio-state.edu/~gerlach/math

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List:

I. VECTOR SPACES (approximately 10 days*)
- Axiomatic properties
- Subspaces
- Spanning sets
- Linear independence
- Bases and coordinates
- Dimension
- Linear functionals and covectors
- Dual of a vector space
- Bilinear functionals
- Metric
- Isomorphism between vector space and its dual

II. LINEAR TRANSFORMATIONS (approximately 10 days)
- Null space, range space
- Dimension Theorem, Implicit Function Theorem for a linear system
- Classification of linear transformations
- Invertible transformations
- Existence and uniqueness of a system of equations
- Algebraic operations with linear transformations
- The Representation Theorem
- Change of basis, change of representation, and the transition matrix
- Invariant subspaces, commuting operators and eigenvectors

III. INNER PRODUCT SPACES (approximately 5 days)
- Inner products
- Orthogonormal bases
- Gram-Schmidt orthogonalization process
- Orthogonal matrices
- Right and left inverses
- Least squares approximation, Bessel's inequality, normal equations
- The four fundamental subspaces of a matrix
- The Fredholm alternative, uniqueness = existence
- Intersection and sum of two vector spaces

IV. EIGENVALUES AND EIGENVECTORS (approximately 5 days)
- Eigenvector basis
- Diagonalizing a matrix
- Generalized eigenvectors
- Phase portrait of a system of linear differential equations
- Powers of a matrix
- Markov processes
- Adjoint of an operator

(* 1 day = one 48 min. lecture)

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 602 **3 credits** **Mathematical Principles in Science II**
Wi

Prerequisite:

Mathematics 601

Catalog Description:

Eigenvalue and eigenvector analysis in finite dimensions, quadratic forms, singular value decomposition, linear analysis in infinite dimensions, Sturm-Liouville Theory, Hilbert spaces.

Purpose of Course:

To make available an updated advanced-undergraduate/graduate course sequence which accommodates the academic (mathematical) and scheduling needs of client departments as well as those of the mathematics department.

Follow-up Course:

Math 603

Possible Topics and Texts:

I. Eigenvalues and eigenvectors:
Linear Algebra and its Applications, Strang, 3rd edition, (Ch. 5, 6, and Appendix A)

II. Infinite-dimensional vector spaces:
Linear Mathematics in Infinite Dimensions, U. Gerlach, (Ch. 1 and 3)
Fourier Series and Boundary Value Problems, Churchill and Brown, (Ch. 3)
Mathematical Methods in Physics and Engineering, Dettman, (Ch. 2)
Website: http://www.math.ohio-state.edu/~gerlach/math

Continued.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

I. EIGENVALUES AND EIGENVECTORS
(approximately 20 days)*

- Hermetian operators
- Spectral Theorem
- Triangularization via unitary similarity transformation
- Diagonalization of normal matrices
- Positive definite matrices
- Quadratic forms and the generalized eigenvalue problem
- Extremization with linear constraints
- Rayleigh quotient
- Singular value decomposition of a rectangular matrix
- Pseudo-inverse of a rectangular matrix

II. INFINITE DIMENSIONAL VECTOR SPACES: EXAMPLES
(II & III approximately 10 days)

- Sturm-Liouville systems: regular, periodic, and singular
- Sturm-Liouville series

III. INFINITE DIMENSIONAL VECTOR SPACES: PRINCIPLES

- Inner product spaces
- Complete metric spaces
- Hilbert spaces
  - Square summable series and square integrable functions
- Least squares approximation
  - Projection theorem
  - Generalized Fourier coefficients
- Bessel's inequality, Parceval's equality and completeness
- Unitary transformation between Hilbert spaces

*(*1 day = one 48 min. lecture)*

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 603.02 **3 cr.** **Mathematical Principles in Science III**
Sp

Prerequisite:

Some complex analysis. Mathematics 514 would be sufficient.

Catalog Description:

An introduction to partial differential equations (pdes) that arise in the mathematical and engineering sciences. Mathematical principles and methods in the physical and engineering sciences including Fourier theory, Green's function theory, study of pdes illustrated mainly by the Helmholtz equation.

Purpose of Course:

To make available an updated advanced-undergraduate/graduate course sequence which accommodates the academic (mathematical) and scheduling needs of client departments as well as those of the mathematics department.

Text:

Linear Mathematics in Infinite Dimensions, Gerlach (Ch. 2, 4, 5)

I. Fourier Theory:
Fourier Series and Boundary Value Problems, Churchill and Brown, (Ch. 4, 5, 7)

II. Green's Function Theory:
Principles of Applied Mathematics, Friedman, (Ch. 3-5)

III. Theory of solutions to partial differential equations in 2 and 3 dimensions:
Partial Differential Equations in Physics, Sommerfeld, (Ch. IV, II)
Mathematical Methods of Physics, Mathews and Walker, (Ch. 8)
Website: http://www.math.ohio-state.edu/~gerlach/math

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

I. FOURIER THEORY
(I & II approximately 20 days)*
- Fourier series
- Dirichelet kernel
- Fourier's Theorem on a finite domain
- Sequences leading to the Dirac delta function
- Fourier transform representation
- Change of basis in Hilbert space:
  - Orthonormal wavelet and wavepacket representations

II. GREEN'S FUNCTION THEORY: INHOMOGENEOUS DIFFERENTIAL EQUATIONS
- Homogeneous systems
- Adjoint systems
- Inhomogeneous systems
- The concept of a Green's function
- Solution via Green's function
- Integral equation of a linear system via its Green's function
- Classification of integral equations
- The Fredholm alternative
- Green's function and the resolvent of the operator of a system
- Eigenfunctions and eigenvalues via residue calculus
- Branches, branch cuts, and Riemann sheets
- Singularity structure of the resolvent of a system:
  - Poles and branch cuts
  - Effect of boundary conditions and domain size

III. THEORY OF SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS IN TWO AND THREE DIMENSIONS
(approximately 10 days)
- Partial differential equations: hyperbolic, parabolic, and elliptic
- The Helmholtz equation and its solutions in the Euclidean plane
  - Geometry of the space of solutions
  - Plane waves vs. cylinder waves:
  - Why, and when to use them
  - Sommerfeld's integral representation
  - Hankel, Bessel, and Neumann waves
  - Change of basis in the space of solutions: partial waves
  - Displaced cylinder waves
  - The Cylindrical Addition Theorem
  - Method of steepest descent and stationary phase
- Analytic behavior of cylinder waves
- Interior (cavity) and exterior (scattering) boundary value problems
- Cauchy problem and characteristics
- Spherical waves: symmetric and nonsymmetric

*(*1 day = one 48 min. lecture)*

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231 WEST EIGHTEENTH AVENUE
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Mathematics 618 **4 cr.** **Theory of Interest**
Au

Prerequisite:

Mathematics 254, or permission of instructor.

Catalog Description:

Mathematical techniques of use in analyzing financial transactions involving interest: measurement of interest, force of interest, annuities-certain, applications to actuarial sciences, introduction to derivatives.

Purpose of Course:

Undecided students looking to actuarial science as a possible course of study or profession may find this course to be a valuable indicator of their aptitude and interest. This course includes the material on the mathematics of compound interest and financial economics in Examination FM of the Society of Actuaries and the Casualty Actuarial Society. The course is required for the undergraduate major in actuarial science.

Text:

- Mathematics of Investment and Credit, 3rd Edition, by Samuel A. Broverman, ASA, Ph.D., Actex Publications, ISBN 1566984750.
- Derivatives Markets, 2nd Edition, by Robert L. McDonald, Addison Wesley, ISBN 032128030X

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Topics:

The minimum course content is:

1. Measurement of interest and discount, compound interest.
2. Force of interest, equations of value.
3. Annuities-certain, continuous annuities, varying annuities.
4. Amortization, numerical calculation of yield rates.
5. Valuation of securities.
6. Measurement of the rate of return of an investment.
7. Term structure of interest rates.
8. Cashflow duration and immunization.
9. Introduction to derivatives.
10. Forwards and options, insurance, collars, and other strategies.
11. Risk management.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 630	**Au**	**3 cr.**	**Actuarial Mathematics I**
Mathematics 631	**Wi**		**Actuarial Mathematics II**
Mathematics 632	**Sp**		**Actuarial Mathematics III**

Prerequisite:

Mathematics 618 (Can be taken concurrently), and Mathematics 530 or Statistics 420 or equivalent;

Catalog Description:

630: Problem workshop for applications of economics, finance, and theory of interest to actuarial science.

631: Actuarial models and their application to insurance and other financial risks.

632: Continuation of 631; actuarial models and their application to insurance and other financial risks.

Purpose of Courses:

This sequence is designed to introduce students to the mathematical content of the theory of contingencies. The sequence covers the material required for the SOA and CAS exams covering life contingencies. The sequence is required for the undergraduate major in actuarial science.

Text:

Actuarial Mathematics, 2nd edition, by Newton L. Bowers, Jr., et al, Society of Actuaries, ISBN 0938959107.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Math 630, 631, 632
Course Coordinator: R. Evans
2008-2009

Mathematics 650 **5 cr** **Principles of Mathematical Analysis**
Su

Prerequisite:

Mathematics 547 or permission of the Graduate Advising Committee.

Catalog Description:

Riemann-Stieltjes integral; uniform convergence and interchange of limit processes, special functions, Fourier series.

Purpose of Course:

New graduate students in Statistics and Mathematics will form the core of the audience. This group will be supplemented by students from various disciplines. These students need more maturity in mathematical analysis for their graduate work. This course will help them to become aware of main pitfalls in analysis, to realize the need for a rigorous argument, to gain facility in using Mathematica software for graphical and numerical exploration, and--through a detailed study of well-chosen examples—to develop analytic intuition.

Text:

A Radical Approach to Real Analysis, by David Bressoud.

Topics:

Fourier Series
Different Forms of Remainder in Taylor's Formula
Taylor Series (binomial series, $\sin x$, $\cos x$, $\exp x$, $\log(1+x)$, $x/(e^x-1)$, etc.)
The Newton-Raphson Method
Differentiability and Continuity
Hypergeometric Series and Gauss' Convergence Test
Summation by Parts and its Applications
Groupings and Rearrangements. Term by Term Differentiation and Integration.
Bonnet Mean-Value Theorem and Dirichlet-Theorem on Convergence of Fourier Series
Wallis Formula. Bernoulli Numbers and Bernoulli Polynomials. Stirling's Formula.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 651	**Au**	**5 cr. Each**	**Introduction to Real Analysis I**
Mathematics 652	**Wi**		**Introduction to Real Analysis II**
Mathematics 653	**Sp**		**Introduction to Real Analysis III**

Prerequisite:

Permission of Department.

Catalog Description:

651: Real numbers, infinite sequences and series.
652: Continuous functions, differentiable functions and functions of bounded variation; Riemann-Stieltjes integral.
653: Measurable sets and functions, elementary theory of the Lebesgue integral.

Purpose of Course:

Basic analysis course for mathematics M.S. students, Mathematics Ph.D. students with incomplete prerequisites, and a few others. General work on writing proofs, and on analytic intuition. These courses are meant to prepare for the Qualifying Exam in Analysis.

Follow-up Courses:

Math 722: Theory of Probability I
Math 750: Real Analysis I
Math 767: Introduction to the Theory of Approximation I

Possible Texts:

Principles of Mathematical Analysis, 3rd Edition, by Rudin, McGraw-Hill, ISBN 0070856133.

or:
Introduction to Real Functions and Orthogonal Expansions, by B. Sz.-Nagy,
(used 1998-2001)
651: Chapter 1, additional material
652: Chapters 2, 3, 4
653: Chapters 5, 6 and parts of 7 & 8
[Out of print, but arrangements have been made for the text for the course.]

Continued.

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COLUMBUS, OHIO 43210-1174

Possible Texts – cont.:

or:
The Way of Analysis, by R. Strichartz, (used 1995-96); supplementary material may be required

or:
An Introduction to Classical Real Analysis, K. Stromberg, (used 1994-95 and 96-97);
651: Chapters 2 and 3
652: Chapters 4, 5 and 7 (except optional sections)
653: Chapter 6
[Out of print, but may be used for reference]

or:
A First Course in Real Analysis, by S. Berberian
651: Chapters 1-4, 10
652: Chapters 5-9
653: Chapter 11 and supplementary material

or:
Equivalent text chosen by the instructor. If another text is chosen, be sure to cover the Qualifying Exam syllabus.

DEPARTMENT OF MATHEMATICS
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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 655	**Au**	**4 cr. Each**	**Elementary Topology I**
Mathematics 656	**Wi**		**Elementary Topology II**
Mathematics 657	**Sp**		**Elementary Topology III**

Prerequisite:

Permission of Department. Reasonable undergraduate background in calculus in Euclidean spaces - for example H540/H541 and/or an undergraduate course in topology or differential geometry, e.g. 560. Some background in linear algebra (eg. 568) is desirable. For 656 and 657 an introductory course in undergraduate algebra along the lines of 580 is required (may be taken concurrently).

Catalog Descriptions:

655:
Continuity, compactness, product spaces, quotient spaces, connectedness in metric and general topological spaces, surface manifolds, cell complexes.

656:
Continuation of 655; the fundamental group and covering spaces.

657:
Continuation of 656: homology.

Purpose of Course:

The 655-656-657 sequence is an introduction to topology for beginning graduate students and advanced undergraduates. 655 is a quick introduction to basic concepts of point set topology: compactness, connectedness, quotient spaces, manifolds (particularly surfaces). 656 is devoted to the fundamental group and covering spaces, while 657 is an introduction to homology theory.

Follow-up Courses:
Math 860-861-862 for algebraic topology; Math 866-867-868 for differential topology.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Possible Texts:
A Basic Course in Algebraic Topology, 2nd Edition, by Massey/Armstrong, Springer-Verlag, ISBN 0387908390 (used 1991, 2007).
Algebraic Geometry, 3rd Edition, by Hatcher, Cambridge, ISBN 0521795400

An Introduction to Algebraic Topology, Rotman
Basic Topology, by M. A. Armstrong, Springer-Verlag, 1994.
Elements of Algebraic Topology, by J. R. Munkres, Addison-Wesley, 1993.
Algebraic Topology: A First Course, by M. J. Greenberg & J. R. Harper, Addison-Wesley, 1982.
Depending on the background of the students and how much point set topology you want to cover, you might supplement Armstrong with:
Topology, 2nd ed., by J. R. Munkres, Prentice-Hall, 1999.

Topics List:

Metric and topological spaces and continuity
Connectedness and path-connectedness
Compactness, Tychonoff's Theorem
Quotient spaces
Topological manifolds
Classification of closed surfaces
The fundamental group
Seifert-Van Kampen theorem
Covering spaces
Simplicial complexes
Homology groups
Mayer-Vietoris sequence and excision
Brouwer fixed point theorem, degree of a map
Jordan-Brouwer separation theorem
Euler characteristic

Possible Additional Topics:

Metrization theorems
Space-filling curves
Branched covers
Knots and knot groups
Fundamental theorem of algebra & extensions to quaternions & octonions
Borsuk-Ulam theorem
Lefschetz fixed point theorem

See also: http://www.math.ohio-state.edu/~fiedorow/math655

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231 WEST EIGHTEENTH AVENUE
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Mathematics 665	**Wi**	**4 cr. Each**	**Modern Mathematical Methods**
Mathematics 666	**Sp**		**In Relativity Theory I, II**

(NOTE: Offered alternate years. In 2009, Math 665 in Spring only, Math 666 in Autumn only.)

Prerequisite:

Multivariable Calculus, Linear Algebra (Mathematics 568 or 571, but preferably Mathematics 601 or its equivalent), "mathematical maturity" (being able to present solutions to problems in a logical and coherent way), a physics course (e.g. Physics 133).

Catalog Description:

665: Geometry of Minkowski space-time; physical interpretations; tensors; exterior calculus, manifolds; Lie derivatives; parallel transport; torsion; curvature; Cartan's two structural equations; Einstein Field equations.

666: Fluid dynamics, Hamilton-Jacobi theory in curved geometries; geometry and dynamics of homogeneous cosmologies; black holes; local-global properties; entropy; gravitational collapse, space-time symmetries.

Purpose of Course:

To develop an appreciation and the modern machinery for the description of the space-time continuum with emphasis on (1) the underlying differential geometric framework of space-time, and (2) the formulation (motivated from classical mechanics, fluid dynamics, and wave mechanics) for identifying its properties. To provide, among others, an introduction for independent work dealing with geometric dynamical processes (particle, wave, fluid, hydro) in flat or curved space-time.

Text:

Gravitation by C.W. Misner, K.S. Thorne, and J.A. Wheeler
Spacetime Physics by E. Taylor and J.A. Wheeler
Mathematical Methods of Classical Mechanics by V.I. Arnold
Lecture Notes on Elementary Topology and Geometry by I.M. Singer

Website:

For a detailed syllabus, see http://www.math.ohio-state.edu/~gerlach/math665.

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List:

665:
A rapid course in special relativity
Fermi-Walker transport
Lorentz geometry, accelerated frames and event horizons
The acceleration temperature
Tensors (multilinear algebra)
Metric geometry vs symplectic geometry
Exterior calculus
Maxwell field equations
Manifolds
The rotation group SO(3)
Lie derivatives
Parallel transport
Torsion
Curvature
Jacobi's equation of geodesic derivation
Cartan's two structural equations
Metric induced properties
Cartan-Misner curvature calculus

666:
Geodesics as external curves
Geodesics as the bridge between physics and geometry
The stress-energy tensor
Conservation of energy and momentum
Perfect fluids
Hydrodynamics in curved spacetime
Scalar and vectorial form of Stoke's theorem
The Bianchi identities
The moment of rotation
The integral form of Einstein's field equations
Conservation of energy-momentum and the vanishing of the boundary of a boundary
Einstein's equations and its solutions for spherically symmetric configurations
Neutron stars
Hamilton-Jacobi theory and the principle of constructive interference
Hamilton-Jacobi analysis of relativistic and Keplerian particle orbits around a black hole
Geometry and dynamics of the universe
Scalar, vector, and tensor harmonics on the two-sphere
Acoustic and gravitational waves in violent relativistic backgrounds
Gauge invariant perturbation theory on spherically symmetric spacetimes

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Mathematics 670	**Au**	**5 cr. Each**	**Algebra I**
Mathematics 671	**Wi**		**Algebra II**
Mathematics 672	**Sp**		**Algebra III**

(Merged with the H590 sequence, refer to H590.)

Prerequisite:

Permission of Department. Reasonable undergraduate algebra background - for example, 568, 580, 581, 582. At least one year (including linear algebra) strongly recommended. Student should feel comfortable with "proofs".

Catalog Descriptions :

670: Elementary theory of groups, permutation group, Polya theory of counting, rings and ideals, polynomials.

671: Continuation of 670: vector spaces, linear transformations, canonical forms for matrices, linear programming, orthogonality.

672: Continuation of 671: quadratic forms, finite fields, various applications.

Purpose of Course:

Standard entry course for M.S. students in mathematics. A basic aim is to prepare background for Qualifying Examination in Algebra.

Text:

Abstract Algebra, 3rd Edition, by Dummit /Foote, Wiley, ISBN 0471433349 (used 1995, 2002, 2003, 2007)

or
Algebra, Artin (used 1992, 1993, 1994)

or
Topics in Algebra, Herstein.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List & Sample Syllabus:
(Sample syllabus was based on Dummit/Foote used in 2002 and 2003)

Topics	Approximate Time
670:	
Chapters 1 – 5	8 weeks
Chapter 7	2 weeks
671	
Chapter 8	3 weeks
Chapter 9 (9.1 – 9.5)	2.5 weeks
Chapter 10 (10.1 – 10.4)	
Chapter 11 (11.1 – 11.4)	
Chapter 12	4.5 weeks
672	
Chapter 13 (skip inseparable extensions)	
Chapter 14 (skip transcendental extensions and infinite galois extensions)	

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 701 **5 cr.** **Mathematical Principles in Science III:**
Wi *(offered alternate years)* **Calculus of Variations & Tensor Calculus**

Prerequisite:

Math 601 or permission of the department.

Catalog Descriptions:

Introduction to tensor analysis with applications to geometry; elements of the calculus of variations with applications to physical problems.

Purpose of Course:

To develop the mathematical framework surrounding the mechanics of particles and of elastic and fluid media. The development will focus on (1) the important extremum principles in physics, engineering, and mathematics and on (2) the modern mathematical description for the kinematics and dynamics of continuous media.

Texts vary, for example:

Calculus of Variations, by I.M. Gelfand and S.V. Fomin, Dover, ISBN 0486414485
Selected sections from Gravitation by C.S. Misner, K.S. Thorne, and J.A. Wheeler

Website:

http://www.math.ohio-state.edu/~gerlach/math
Click on Mathematics 701.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Topics:

(I)
Classical problems in the calculus of variations
Euler's equation
Constraints and isoperimetric problems
Variable end point problems
Geodesics
Hamilton's principle, Lagrange's equations of motion
Hamilton's equations of motion, phase space
Action as the dynamical phase of a wave, the equation of Hamilton and Jacobi
Particle motion in the field of two attractive centers
Helmholtz's equation in arbitrary curvilinear coordinates
Rayleigh's quotient and the Rayleigh-Ritz method

(II)
Vectors, covectors and reciprocal vectors
Multilinear algebra
Tensors and tensor products
Commutator of two vector fields
Parallel transport of vectors on a manifold, the covariant differential
Derivative of vectors and tensors
Strain-induced parallel transport in an elastic medium
Strain as a deformation in the metric
Parallel transport induced by a metric
Curvature
Tidal acceleration and the equation of geodesic deviation

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231 WEST EIGHTEENTH AVENUE
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Mathematics 578 **5 cr.** **Discrete Mathematical Models**
Sp

Prerequisite:

CS&E 201, 202, or 221, and Mathematics 568, and either Mathematics 530 or Statistics 427 or 420.

Catalog Description:

Analysis and solution of various applied problems using discrete mathematical models; methods used include graph theory, linear optimization, Markov chains and queues.

Purpose of Course:

1. To introduce the mathematical structures and develop the mathematics appropriate for discrete modeling.
2. To demonstrate and encourage use of computers in solving mathematical problems
3. To give students an experience with a real world application for which they can construct a model that can be used to explore possible solutions.
4. To apply mathematical concepts and techniques encountered in earlier courses in the context of discrete modeling in a way that brings a new vividness and interest to the ideas.

Text:

"Discrete Mathematics" (Second Edition) by Norman L Biggs.

Other References:

Discrete Dynamical Systems, Sandefur
Mathematical Modeling, Maki & Thompson
Applying Mathematics, Burghes, Huntly & McDonald
Computer Simulation, Nancy Roberts et al, Addison-Wesley
Applications of Linear Algebra, Anton & Rorres, Wiley
An Introduction to Mathematical Models, Olinick
A variety of different modules available through COMAP
A First Course in Mathematical Modeling, (Second Edition), Giordano, Weir & Fox, Brooks/Cole Publishing Company

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics:
This course can examine a number of different topics in which the tools of discrete mathematics are used in the development of mathematical models. Suggested topics:

1. Discrete deterministic models developed from numerical data.
2. Markov processes
3. Random processes and Monte Carlo simulation.
4. Graph theory, including shortest paths, minimum weight spanning trees, and job scheduling.
5. Network flows and the Ford-Fulkerson algorithm for maximum flow.
6. Additional modeling topics as time and the interests of the instructor permit.

As a pedagogical tool, assignment of a term project involving discrete modeling with class reports the last week of the quarter, is highly recommended.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 580	**Au, Wi**	**3 cr. Each**	**Algebra I**
Mathematics 581	**Wi, Sp**		**Algebra II**
Mathematics 582	**Sp, Au**		**Algebra III**

Prerequisite:

580: Mathematics 568 (may be taken concurrently with 580) and Mathematics 345.
581: Mathematics 580 or H590
582: Mathematics 581 or H591

Catalog Description:

The integrated algebra sequence 580, 581, 582 includes elementary number theory, group theory, vector spaces and linear transformations, field theory.

Purpose of Course:

The 580-581-582 sequence covers topics in the theory of polynomial equations, number theory, linear algebra, and algebraic structures in a unified and integrated way.

The principal goal of the sequence is to show how abstract algebraic structures and methods deepen and enrich our understanding of the basic structures and concepts of school mathematics- numbers and arithmetic, polynomial equations, congruence and symmetry, ruler and compass constructions.

Text:

Shapes, Numbers, and Polynomials, lecture notes by Ronald Solomon.

Topics:

580: Groups; Group actions and symmetry.

581: Rings and Polynomials; Number systems; Elementary Number Theory.

582: Field extensions; Introduction of Galois Theory.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics H590	**Au**	**5 cr. Each**	**Algebraic Structures I**
Mathematics H591	**Wi**		**Algebraic Structures II**
Mathematics H592	**Sp**		**Algebraic Structures III**

Prerequisite:

H590: H520 with a grade of C or better, or written permission of Honors Committee Chair
H591: H590 with a grade of C or better, or written permission of Honors Committee Chair
H592: H591 with a grade of C or better, or written permission of Honors Committee Chair

Catalog Description:

Integers, congruence relations, structure preserving maps, topics from groups, rings, modules, vector spaces, fields. The sequence H590, H591, H592 substitutes for the sequence 580, 581, 582.

Text:

Vary, for example:
Abstract Algebra, 3rd Edition, by D. Dummit/R. Foote, Wiley, ISBN 0471433349 (2004-2007)
Algebra, by M. Artin
Topics in Algebra, by I. Herstein

Suggested Topics:

H590:

1. Integers, unique factorization; congruences, Euler function.
2. Groups, subgroups, homomorphisms and isomorphisms, normal subgroups, quotient groups, permutation groups, cyclic groups, Cauchy Theorems, Sylow's Theorems; direct products, fundamental theorem for finite Abelian group; G-sets.
3. Rings, subrings, ideals, morphisms, polynomial rings, prime and maximal ideals.

Continued.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

H591:

1. Commutative rings, factorization theory, Euclidean rings, principal ideal rings, unique factorization domains, Gauss' lemma; illustrations in the integers of quadratic number fields.
2. Modules over commutative rings, submodules, quotients and direct sums; fundamental theorem for modules over principal ideal domains.
3. Vector spaces (as a special case of modules); linear maps and matrices, canonical forms, dual spaces.
4. The theory of determinants.

H592:

1. Bilinear and quadratic forms; inner product and unitary spaces; principal axis theorem.
2. Fields, algebraic and transcendental (extensions), existence of closure (over countable fields), tests for polynomial irreducibility; normality, separability, field automorphisms.
3. Galois theory, the subgroup-subfield correspondence theorem, group theory interrelations; extensions of finite fields, cyclotomic extensions.
4. Solvable groups and solvability by radicals.

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Mathematics H594 **5 credits** **Rigorous Probability**
Au

Prerequisite:

Math H264

Catalog Description:

A rigorous honors course on probability theory with special attention to applications within and outside mathematics.

Purpose of Course:

The acquaintance with rigorous probability theory, its history and its multiple connections, will better prepare these high quality students for graduate studies and will help them get involved in research at earlier stages of their careers.

Suggested Texts:

Elementary Probability Theory with Stochastic Processes, Kai Lai Chung
Probability Theory - A Concise Course, Y. Rosanov
Heads and Tails. An Introduction to Limit Theorems in Probability, E. Lesigne
The Pleasures of Probability, Richard Isaac
Statistical Inference in Probability, Analysis and Number Theory, M. Kac.

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COLUMBUS, OHIO 43210-1174

Mathematics 601 **3 cr.** **Mathematical Principles in Science I**
Au

Prerequisites:

Several quarters of mathematics at the 400-500 level, including Mathematics 568 or 571.

Catalog Description:

Linear algebra in finite dimensions, abstract vector spaces, linear transformations, fundamental subspaces, complex inner product spaces.

Purpose of Course:

To make available an updated advanced-undergraduate/graduate course sequence which accommodates the academic (mathematical) and scheduling needs of client departments as well as those of the mathematics department.

Follow-up Course:

Math 602

Text:

Linear Algebra and its Applications, 3rd Edition, by Strang, Harcourt, ISBN 0155510053 (chapter 5). However later editions are also okay.

Introduction to Linear Algebra, Johnson, Riess & Arnold, (chapter 4)

Website:
http://www.math.ohio-state.edu/~gerlach/math

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List:

I. VECTOR SPACES (approximately 10 days*)
- Axiomatic properties
- Subspaces
- Spanning sets
- Linear independence
- Bases and coordinates
- Dimension
- Linear functionals and covectors
- Dual of a vector space
- Bilinear functionals
- Metric
- Isomorphism between vector space and its dual

II. LINEAR TRANSFORMATIONS (approximately 10 days)
- Null space, range space
- Dimension Theorem, Implicit Function Theorem for a linear system
- Classification of linear transformations
- Invertible transformations
- Existence and uniqueness of a system of equations
- Algebraic operations with linear transformations
- The Representation Theorem
- Change of basis, change of representation, and the transition matrix
- Invariant subspaces, commuting operators and eigenvectors

III. INNER PRODUCT SPACES (approximately 5 days)
- Inner products
- Orthogonormal bases
- Gram-Schmidt orthogonalization process
- Orthogonal matrices
- Right and left inverses
- Least squares approximation, Bessel's inequality, normal equations
- The four fundamental subspaces of a matrix
- The Fredholm alternative, uniqueness = existence
- Intersection and sum of two vector spaces

IV. EIGENVALUES AND EIGENVECTORS (approximately 5 days)
- Eigenvector basis
- Diagonalizing a matrix
- Generalized eigenvectors
- Phase portrait of a system of linear differential equations
- Powers of a matrix
- Markov processes
- Adjoint of an operator

(* 1 day = one 48 min. lecture)

DEPARTMENT OF MATHEMATICS
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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 602 **3 credits** **Mathematical Principles in Science II**
Wi

Prerequisite:

Mathematics 601

Catalog Description:

Eigenvalue and eigenvector analysis in finite dimensions, quadratic forms, singular value decomposition, linear analysis in infinite dimensions, Sturm-Liouville Theory, Hilbert spaces.

Purpose of Course:

To make available an updated advanced-undergraduate/graduate course sequence which accommodates the academic (mathematical) and scheduling needs of client departments as well as those of the mathematics department.

Follow-up Course:

Math 603

Possible Topics and Texts:

I. Eigenvalues and eigenvectors:
Linear Algebra and its Applications, Strang, 3rd edition, (Ch. 5, 6, and Appendix A)

II. Infinite-dimensional vector spaces:
Linear Mathematics in Infinite Dimensions, U. Gerlach, (Ch. 1 and 3)
Fourier Series and Boundary Value Problems, Churchill and Brown, (Ch. 3)
Mathematical Methods in Physics and Engineering, Dettman, (Ch. 2)
Website: http://www.math.ohio-state.edu/~gerlach/math

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List:

I. EIGENVALUES AND EIGENVECTORS
(approximately 20 days)*

- Hermetian operators
- Spectral Theorem
- Triangularization via unitary similarity transformation
- Diagonalization of normal matrices
- Positive definite matrices
- Quadratic forms and the generalized eigenvalue problem
- Extremization with linear constraints
- Rayleigh quotient
- Singular value decomposition of a rectangular matrix
- Pseudo-inverse of a rectangular matrix

II. INFINITE DIMENSIONAL VECTOR SPACES: EXAMPLES
(II & III approximately 10 days)

- Sturm-Liouville systems: regular, periodic, and singular
- Sturm-Liouville series

III. INFINITE DIMENSIONAL VECTOR SPACES: PRINCIPLES

- Inner product spaces
- Complete metric spaces
- Hilbert spaces
  - Square summable series and square integrable functions
- Least squares approximation
  - Projection theorem
  - Generalized Fourier coefficients
- Bessel's inequality, Parceval's equality and completeness
- Unitary transformation between Hilbert spaces

*(*1 day = one 48 min. lecture)*

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231 WEST EIGHTEENTH AVENUE
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Mathematics 603.02 **3 cr.** **Mathematical Principles in Science III**
Sp

Prerequisite:

Some complex analysis. Mathematics 514 would be sufficient.

Catalog Description:

An introduction to partial differential equations (pdes) that arise in the mathematical and engineering sciences. Mathematical principles and methods in the physical and engineering sciences including Fourier theory, Green's function theory, study of pdes illustrated mainly by the Helmholtz equation.

Purpose of Course:

To make available an updated advanced-undergraduate/graduate course sequence which accommodates the academic (mathematical) and scheduling needs of client departments as well as those of the mathematics department.

Text:

Linear Mathematics in Infinite Dimensions, Gerlach (Ch. 2, 4, 5)

I. Fourier Theory:
Fourier Series and Boundary Value Problems, Churchill and Brown, (Ch. 4, 5, 7)

II. Green's Function Theory:
Principles of Applied Mathematics, Friedman, (Ch. 3-5)

III. Theory of solutions to partial differential equations in 2 and 3 dimensions:
Partial Differential Equations in Physics, Sommerfeld, (Ch. IV, II)
Mathematical Methods of Physics, Mathews and Walker, (Ch. 8)
Website: http://www.math.ohio-state.edu/~gerlach/math

Continued.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Topics List:

I. FOURIER THEORY
(I & II approximately 20 days)*
- Fourier series
- Dirichelet kernel
- Fourier's Theorem on a finite domain
- Sequences leading to the Dirac delta function
- Fourier transform representation
- Change of basis in Hilbert space:
  - Orthonormal wavelet and wavepacket representations

II. GREEN'S FUNCTION THEORY: INHOMOGENEOUS DIFFERENTIAL EQUATIONS
- Homogeneous systems
- Adjoint systems
- Inhomogeneous systems
- The concept of a Green's function
- Solution via Green's function
- Integral equation of a linear system via its Green's function
- Classification of integral equations
- The Fredholm alternative
- Green's function and the resolvent of the operator of a system
- Eigenfunctions and eigenvalues via residue calculus
- Branches, branch cuts, and Riemann sheets
- Singularity structure of the resolvent of a system:
  - Poles and branch cuts
  - Effect of boundary conditions and domain size

III. THEORY OF SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS IN TWO AND THREE DIMENSIONS
(approximately 10 days)
- Partial differential equations: hyperbolic, parabolic, and elliptic
- The Helmholtz equation and its solutions in the Euclidean plane
  - Geometry of the space of solutions
  - Plane waves vs. cylinder waves:
  - Why, and when to use them
  - Sommerfeld's integral representation
  - Hankel, Bessel, and Neumann waves
  - Change of basis in the space of solutions: partial waves
  - Displaced cylinder waves
  - The Cylindrical Addition Theorem
  - Method of steepest descent and stationary phase
- Analytic behavior of cylinder waves
- Interior (cavity) and exterior (scattering) boundary value problems
- Cauchy problem and characteristics
- Spherical waves: symmetric and nonsymmetric

*(*1 day = one 48 min. lecture)*

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231 WEST EIGHTEENTH AVENUE
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Mathematics 618 **4 cr.** **Theory of Interest**
Au

Prerequisite:

Mathematics 254, or permission of instructor.

Catalog Description:

Mathematical techniques of use in analyzing financial transactions involving interest: measurement of interest, force of interest, annuities-certain, applications to actuarial sciences, introduction to derivatives.

Purpose of Course:

Undecided students looking to actuarial science as a possible course of study or profession may find this course to be a valuable indicator of their aptitude and interest. This course includes the material on the mathematics of compound interest and financial economics in Examination FM of the Society of Actuaries and the Casualty Actuarial Society. The course is required for the undergraduate major in actuarial science.

Text:

- Mathematics of Investment and Credit, 3rd Edition, by Samuel A. Broverman, ASA, Ph.D., Actex Publications, ISBN 1566984750.
- Derivatives Markets, 2nd Edition, by Robert L. McDonald, Addison Wesley, ISBN 032128030X

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics:

The minimum course content is:

1. Measurement of interest and discount, compound interest.
2. Force of interest, equations of value.
3. Annuities-certain, continuous annuities, varying annuities.
4. Amortization, numerical calculation of yield rates.
5. Valuation of securities.
6. Measurement of the rate of return of an investment.
7. Term structure of interest rates.
8. Cashflow duration and immunization.
9. Introduction to derivatives.
10. Forwards and options, insurance, collars, and other strategies.
11. Risk management.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 630	**Au**	**3 cr.**	**Actuarial Mathematics I**
Mathematics 631	**Wi**		**Actuarial Mathematics II**
Mathematics 632	**Sp**		**Actuarial Mathematics III**

Prerequisite:

Mathematics 618 (Can be taken concurrently), and Mathematics 530 or Statistics 420 or equivalent;

Catalog Description:

630: Problem workshop for applications of economics, finance, and theory of interest to actuarial science.

631: Actuarial models and their application to insurance and other financial risks.

632: Continuation of 631; actuarial models and their application to insurance and other financial risks.

Purpose of Courses:

This sequence is designed to introduce students to the mathematical content of the theory of contingencies. The sequence covers the material required for the SOA and CAS exams covering life contingencies. The sequence is required for the undergraduate major in actuarial science.

Text:

Actuarial Mathematics, 2nd edition, by Newton L. Bowers, Jr., et al, Society of Actuaries, ISBN 0938959107.

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COLUMBUS, OHIO 43210-1174

Mathematics 650 **5 cr** **Principles of Mathematical Analysis**
Su

Prerequisite:

Mathematics 547 or permission of the Graduate Advising Committee.

Catalog Description:

Riemann-Stieltjes integral; uniform convergence and interchange of limit processes, special functions, Fourier series.

Purpose of Course:

New graduate students in Statistics and Mathematics will form the core of the audience. This group will be supplemented by students from various disciplines. These students need more maturity in mathematical analysis for their graduate work. This course will help them to become aware of main pitfalls in analysis, to realize the need for a rigorous argument, to gain facility in using Mathematica software for graphical and numerical exploration, and--through a detailed study of well-chosen examples—to develop analytic intuition.

Text:

A Radical Approach to Real Analysis, by David Bressoud.

Topics:

Fourier Series
Different Forms of Remainder in Taylor's Formula
Taylor Series (binomial series, $\sin x$, $\cos x$, $\exp x$, $\log(1+x)$, $x/(e^x-1)$, etc.)
The Newton-Raphson Method
Differentiability and Continuity
Hypergeometric Series and Gauss' Convergence Test
Summation by Parts and its Applications
Groupings and Rearrangements. Term by Term Differentiation and Integration.
Bonnet Mean-Value Theorem and Dirichlet-Theorem on Convergence of Fourier Series
Wallis Formula. Bernoulli Numbers and Bernoulli Polynomials. Stirling's Formula.

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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 651	**Au**	**5 cr. Each**	**Introduction to Real Analysis I**
Mathematics 652	**Wi**		**Introduction to Real Analysis II**
Mathematics 653	**Sp**		**Introduction to Real Analysis III**

Prerequisite:

Permission of Department.

Catalog Description:

651: Real numbers, infinite sequences and series.
652: Continuous functions, differentiable functions and functions of bounded variation; Riemann-Stieltjes integral.
653: Measurable sets and functions, elementary theory of the Lebesgue integral.

Purpose of Course:

Basic analysis course for mathematics M.S. students, Mathematics Ph.D. students with incomplete prerequisites, and a few others. General work on writing proofs, and on analytic intuition. These courses are meant to prepare for the Qualifying Exam in Analysis.

Follow-up Courses:

Math 722: Theory of Probability I
Math 750: Real Analysis I
Math 767: Introduction to the Theory of Approximation I

Possible Texts:

Principles of Mathematical Analysis, 3rd Edition, by Rudin, McGraw-Hill, ISBN 0070856133.

or:
Introduction to Real Functions and Orthogonal Expansions, by B. Sz.-Nagy,
(used 1998-2001)
651: Chapter 1, additional material
652: Chapters 2, 3, 4
653: Chapters 5, 6 and parts of 7 & 8
[Out of print, but arrangements have been made for the text for the course.]

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Possible Texts – cont.:

or:
The Way of Analysis, by R. Strichartz, (used 1995-96); supplementary material may be required

or:
An Introduction to Classical Real Analysis, K. Stromberg, (used 1994-95 and 96-97);
651: Chapters 2 and 3
652: Chapters 4, 5 and 7 (except optional sections)
653: Chapter 6
[Out of print, but may be used for reference]

or:
A First Course in Real Analysis, by S. Berberian
651: Chapters 1-4, 10
652: Chapters 5-9
653: Chapter 11 and supplementary material

or:
Equivalent text chosen by the instructor. If another text is chosen, be sure to cover the Qualifying Exam syllabus.

DEPARTMENT OF MATHEMATICS
THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 655	**Au**	**4 cr. Each**	**Elementary Topology I**
Mathematics 656	**Wi**		**Elementary Topology II**
Mathematics 657	**Sp**		**Elementary Topology III**

Prerequisite:

Permission of Department. Reasonable undergraduate background in calculus in Euclidean spaces - for example H540/H541 and/or an undergraduate course in topology or differential geometry, e.g. 560. Some background in linear algebra (eg. 568) is desirable. For 656 and 657 an introductory course in undergraduate algebra along the lines of 580 is required (may be taken concurrently).

Catalog Descriptions:

655:
Continuity, compactness, product spaces, quotient spaces, connectedness in metric and general topological spaces, surface manifolds, cell complexes.

656:
Continuation of 655; the fundamental group and covering spaces.

657:
Continuation of 656: homology.

Purpose of Course:

The 655-656-657 sequence is an introduction to topology for beginning graduate students and advanced undergraduates. 655 is a quick introduction to basic concepts of point set topology: compactness, connectedness, quotient spaces, manifolds (particularly surfaces). 656 is devoted to the fundamental group and covering spaces, while 657 is an introduction to homology theory.

Follow-up Courses:
Math 860-861-862 for algebraic topology; Math 866-867-868 for differential topology.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Possible Texts:
A Basic Course in Algebraic Topology, 2nd Edition, by Massey/Armstrong, Springer-Verlag, ISBN 0387908390 (used 1991, 2007).
Algebraic Geometry, 3rd Edition, by Hatcher, Cambridge, ISBN 0521795400

An Introduction to Algebraic Topology, Rotman
Basic Topology, by M. A. Armstrong, Springer-Verlag, 1994.
Elements of Algebraic Topology, by J. R. Munkres, Addison-Wesley, 1993.
Algebraic Topology: A First Course, by M. J. Greenberg & J. R. Harper, Addison-Wesley, 1982.
Depending on the background of the students and how much point set topology you want to cover, you might supplement Armstrong with:
Topology, 2nd ed., by J. R. Munkres, Prentice-Hall, 1999.

Topics List:

Metric and topological spaces and continuity
Connectedness and path-connectedness
Compactness, Tychonoff's Theorem
Quotient spaces
Topological manifolds
Classification of closed surfaces
The fundamental group
Seifert-Van Kampen theorem
Covering spaces
Simplicial complexes
Homology groups
Mayer-Vietoris sequence and excision
Brouwer fixed point theorem, degree of a map
Jordan-Brouwer separation theorem
Euler characteristic

Possible Additional Topics:

Metrization theorems
Space-filling curves
Branched covers
Knots and knot groups
Fundamental theorem of algebra & extensions to quaternions & octonions
Borsuk-Ulam theorem
Lefschetz fixed point theorem

See also: http://www.math.ohio-state.edu/~fiedorow/math655

DEPARTMENT OF MATHEMATICS
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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 665	**Wi**	**4 cr. Each**	**Modern Mathematical Methods**
Mathematics 666	**Sp**		**In Relativity Theory I, II**

(NOTE: Offered alternate years. In 2009, Math 665 in Spring only, Math 666 in Autumn only.)

Prerequisite:

Multivariable Calculus, Linear Algebra (Mathematics 568 or 571, but preferably Mathematics 601 or its equivalent), "mathematical maturity" (being able to present solutions to problems in a logical and coherent way), a physics course (e.g. Physics 133).

Catalog Description:

665: Geometry of Minkowski space-time; physical interpretations; tensors; exterior calculus, manifolds; Lie derivatives; parallel transport; torsion; curvature; Cartan's two structural equations; Einstein Field equations.

666: Fluid dynamics, Hamilton-Jacobi theory in curved geometries; geometry and dynamics of homogeneous cosmologies; black holes; local-global properties; entropy; gravitational collapse, space-time symmetries.

Purpose of Course:

To develop an appreciation and the modern machinery for the description of the space-time continuum with emphasis on (1) the underlying differential geometric framework of space-time, and (2) the formulation (motivated from classical mechanics, fluid dynamics, and wave mechanics) for identifying its properties. To provide, among others, an introduction for independent work dealing with geometric dynamical processes (particle, wave, fluid, hydro) in flat or curved space-time.

Text:

Gravitation by C.W. Misner, K.S. Thorne, and J.A. Wheeler
Spacetime Physics by E. Taylor and J.A. Wheeler
Mathematical Methods of Classical Mechanics by V.I. Arnold
Lecture Notes on Elementary Topology and Geometry by I.M. Singer

Website:

For a detailed syllabus, see http://www.math.ohio-state.edu/~gerlach/math665.

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List:

665:
A rapid course in special relativity
Fermi-Walker transport
Lorentz geometry, accelerated frames and event horizons
The acceleration temperature
Tensors (multilinear algebra)
Metric geometry vs symplectic geometry
Exterior calculus
Maxwell field equations
Manifolds
The rotation group SO(3)
Lie derivatives
Parallel transport
Torsion
Curvature
Jacobi's equation of geodesic derivation
Cartan's two structural equations
Metric induced properties
Cartan-Misner curvature calculus

666:
Geodesics as external curves
Geodesics as the bridge between physics and geometry
The stress-energy tensor
Conservation of energy and momentum
Perfect fluids
Hydrodynamics in curved spacetime
Scalar and vectorial form of Stoke's theorem
The Bianchi identities
The moment of rotation
The integral form of Einstein's field equations
Conservation of energy-momentum and the vanishing of the boundary of a boundary
Einstein's equations and its solutions for spherically symmetric configurations
Neutron stars
Hamilton-Jacobi theory and the principle of constructive interference
Hamilton-Jacobi analysis of relativistic and Keplerian particle orbits around a black hole
Geometry and dynamics of the universe
Scalar, vector, and tensor harmonics on the two-sphere
Acoustic and gravitational waves in violent relativistic backgrounds
Gauge invariant perturbation theory on spherically symmetric spacetimes

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231 WEST EIGHTEENTH AVENUE
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Mathematics 670	**Au**	**5 cr. Each**	**Algebra I**
Mathematics 671	**Wi**		**Algebra II**
Mathematics 672	**Sp**		**Algebra III**

(Merged with the H590 sequence, refer to H590.)

Prerequisite:

Permission of Department. Reasonable undergraduate algebra background - for example, 568, 580, 581, 582. At least one year (including linear algebra) strongly recommended. Student should feel comfortable with "proofs".

Catalog Descriptions :

670: Elementary theory of groups, permutation group, Polya theory of counting, rings and ideals, polynomials.

671: Continuation of 670: vector spaces, linear transformations, canonical forms for matrices, linear programming, orthogonality.

672: Continuation of 671: quadratic forms, finite fields, various applications.

Purpose of Course:

Standard entry course for M.S. students in mathematics. A basic aim is to prepare background for Qualifying Examination in Algebra.

Text:

Abstract Algebra, 3rd Edition, by Dummit /Foote, Wiley, ISBN 0471433349 (used 1995, 2002, 2003, 2007)

or
Algebra, Artin (used 1992, 1993, 1994)

or
Topics in Algebra, Herstein.

Continued.

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231 WEST EIGHTEENTH AVENUE
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Topics List & Sample Syllabus:
(Sample syllabus was based on Dummit/Foote used in 2002 and 2003)

Topics	Approximate Time
670:	
Chapters 1 – 5	8 weeks
Chapter 7	2 weeks
671	
Chapter 8	3 weeks
Chapter 9 (9.1 – 9.5)	2.5 weeks
Chapter 10 (10.1 – 10.4)	
Chapter 11 (11.1 – 11.4)	
Chapter 12	4.5 weeks
672	
Chapter 13 (skip inseparable extensions)	
Chapter 14 (skip transcendental extensions and infinite galois extensions)	

DEPARTMENT OF MATHEMATICS
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231 WEST EIGHTEENTH AVENUE
COLUMBUS, OHIO 43210-1174

Mathematics 701 **5 cr.** **Mathematical Principles in Science III:**
Wi *(offered alternate years)* **Calculus of Variations & Tensor Calculus**

Prerequisite:

Math 601 or permission of the department.

Catalog Descriptions:

Introduction to tensor analysis with applications to geometry; elements of the calculus of variations with applications to physical problems.

Purpose of Course:

To develop the mathematical framework surrounding the mechanics of particles and of elastic and fluid media. The development will focus on (1) the important extremum principles in physics, engineering, and mathematics and on (2) the modern mathematical description for the kinematics and dynamics of continuous media.

Texts vary, for example:

Calculus of Variations, by I.M. Gelfand and S.V. Fomin, Dover, ISBN 0486414485
Selected sections from Gravitation by C.S. Misner, K.S. Thorne, and J.A. Wheeler

Website:

http://www.math.ohio-state.edu/~gerlach/math
Click on Mathematics 701.

Continued.

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THE OHIO STATE UNIVERSITY
231 WEST EIGHTEENTH AVENUE
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Topics:

(I)
Classical problems in the calculus of variations
Euler's equation
Constraints and isoperimetric problems
Variable end point problems
Geodesics
Hamilton's principle, Lagrange's equations of motion
Hamilton's equations of motion, phase space
Action as the dynamical phase of a wave, the equation of Hamilton and Jacobi
Particle motion in the field of two attractive centers
Helmholtz's equation in arbitrary curvilinear coordinates
Rayleigh's quotient and the Rayleigh-Ritz method

(II)
Vectors, covectors and reciprocal vectors
Multilinear algebra
Tensors and tensor products
Commutator of two vector fields
Parallel transport of vectors on a manifold, the covariant differential
Derivative of vectors and tensors
Strain-induced parallel transport in an elastic medium
Strain as a deformation in the metric
Parallel transport induced by a metric
Curvature
Tidal acceleration and the equation of geodesic deviation

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