Department of Mathematics
The Ohio State University

2009-2010 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
152.01	Calculus and Analytic Geometry
153.01	Calculus and Analytic
161.01	Accelerated Calculus with Analytic Geometry
162.01	Accelerated Calculus with Analytic Geometry
263.01	Accelerated Calculus with Analytic Geometry
161.01H	Accelerated Calculus with Analytic Geometry
162.01H	Accelerated Calculus with Analytic Geometry
263.01H	Accelerated Calculus with Analytic Geometry
161.02	Accelerated Calculus with Analytic Geometry I
162.02	Accelerated Calculus with Analytic Geometry II
263.02	Accelerated Calculus with Analytic Geometry III
187.01H	Advanced Problem Solving
487H	Advanced Problem Solving
190H	Elementary Analysis I
191H	Elementary Analysis II
264H	Elementary Analysis III

Course Number	Course Title
212	History of Mathematics for Middle School Teachers
254.01	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
531H	Rigorous 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
580	Algebra I
581	Algebra II
582	Algebra III
585	Introduction to Coding Theory and Design Theory
588	Practicum in Actuarial Science

Course Number	Course Title
590H	Algebraic Structures I
591H	Algebraic Structures II
592H	Algebraic Structures III
601	Mathematical Principles in Science I
602	Mathematical Principles in Science II
603.02	Mathematical Principles in Science III
615	Applied Differential Equations I
616	Applied Differential Equations II
617	Applied Differential Equations III
618	Theory of Interest
630	Actuarial Mathematics I
631	Actuarial Mathematics II
632	Actuarial Mathematics III
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
701	Mathematical Principles in Science III: Calculus of Variations & Tensor Calculus

Mathematics 50 **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.

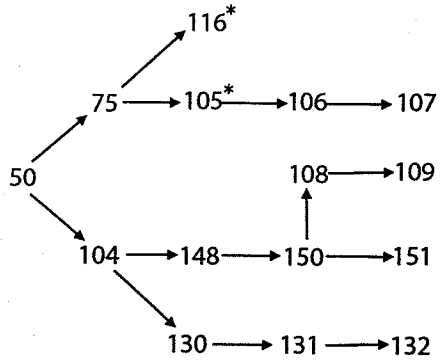
Purpose of Course:

Mathematics 50 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 75 or 104. Math conditions are removed by completion of 50 and 75 or 50 and 104.

Follow-up Course:

Math 75 or Math 104

Sequencing Chart:



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

Text:

Beginning Algebra With Applications, 7th edition, by Aufmann/Barker/Lockwood, Cengage. Chapters 1 – 8 (omit Chapter 6 and Sections 5.5, 5.6 and 8.5).

Continued:

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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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Mathematics 75 **4 credits** **Pre-College Mathematics II**
Au, Wi, Sp, Su

Prerequisite:
Mathematics 50, or Course Code S on Math Placement Test. Not open to students with credit for any math course except 50.

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

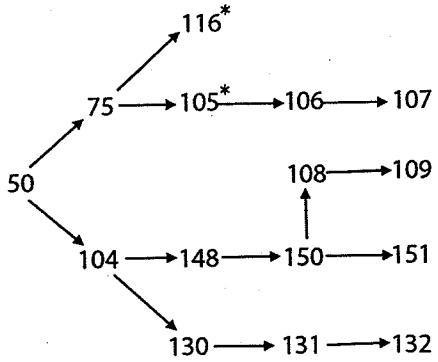
Purpose of Course:
To meet the needs of students entering the University with Course Code S on Math Placement Test, or with credit for 50. In addition, students placing at Course Code R and who need Math 130, must take 104 prior to enrolling in 130. Completion of Math 75 is required for entry into numerous degree granting colleges; however, credit for 75 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 recommended.

Text:
Beginning Algebra With Applications, 7th Edition, Aufmann/Barker/Lockwood, Cengage
ISBN 9780618969913

Continued:

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Topics List:

5.3–5.4 Graphing
- Slopes of straight lines
- Slope-intercept form
- Point-slope form

6.1–6.4 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

8.1–8.5 Factoring polynomials
- Greatest common factor and factoring by grouping
- Factoring trinomials
- Factoring binomials
- Solving quadratic equations by factoring

9.1–9.7 Rational expressions
- Simplifying rational expressions
- Multiplying and dividing rational expressions
- Least common denominator
- Adding and subtracting rational expressions
- Complex fractions
- Solving equations containing rational expressions
- Ratio and proportion
- Rational equations and problem solving

10.1–10.4 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

11.1–11.4 Quadratic equations
- Solving quadratic equations by the square root method
- Solving quadratic equations by completing the square
- Solving quadratic equations by the quadratic formula
- Complex numbers

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Mathematics 104 **5 credits** **Basic College Mathematics**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 50, or 75, 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.

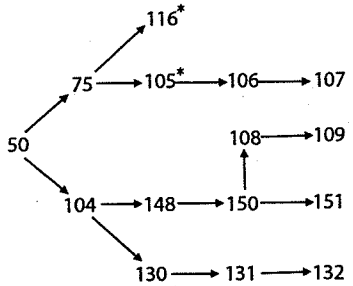
Purpose of Course:

To meet the needs of students entering the University with Course Code R or with credit for 50 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:

Beginning and Intermediate Algebra for The Ohio State University, 2nd edition, by Hall/Mercer, McGraw-Hill, ISBN 0077379055.

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Topics List

Section	Topics
3.1/3.2	Slope of a Line and Linear Equations
3.3	Solving Systems of Linear Equations in Two Variables Graphically and Numerically
3.4/3.5	Solving Systems of Linear Equations using the Substitution and Addition Methods
3.6	More Applications of Linear Systems
4.1/4.2	Solving Linear Inequalities
4.3	Compound Inequalities
4.4	Absolute Value Equations and Inequalities
6.1	An Introduction to Factoring polynomials

Review and Exam 1

6.2/6.3	Factoring Trinomials
6.4/6.5	Special Forms and a General Strategy for Factoring Polynomials
6.6	Solving Equations by Factoring
7.1	Functions and Representation of Functions
7.2/7.3	Absolute Value and Quadratic Functions
7.4	Using the Quadratic Formula to Find Real Solutions
7.5/7.6	Application of Quadratic Equations
7.7	Complex Numbers and Quadratic Equations with Complex Solutions

Review and Exam 2

8.1	Graphs of Rational Functions and Reducing Rational Expressions
8.2/8.3	Operations on Rational Expressions
8.4	Combining Operations and Simplifying Complex Rational Expressions
8.5	Equations Containing Rational Expressions
9.1	Evaluating Radical Expressions and Graphing Square Root and Cube Root Functions
9.2	Adding and Subtracting Radical Expressions
9.3	Multiplying and Dividing Radical Expressions
9.4	Equations Containing Radical Expressions
9.5	Rational Exponents and Radicals
Appendix	Horizontal and Vertical Translations of the Graphs of Functions

Review and Exam 3

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Mathematics 105 **5 credits** **Fundamental Mathematics**
Su, Au, Wi **Concepts for Teachers I**

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

Prerequisite:

Mathematics 75 or 104, or Course Code L, M, N or R on Math Placement Test.

Catalog Description:

Development of basic ideas of arithmetic as appropriate for early 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. *Appropriate for those preparing to become early childhood educators and for those preparing to teach subjects other than math in middle school.*

Follow-up Course:

Math 106

Text:

Mathematics for Elementary Teachers with Activities Manual, 2nd Edition, (2008) by Sybilla Beckmann, Pearson, 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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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.

Catalog Description:

Continuation of Math 105. Development of basic ideas of geometry as appropriate for early 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. *Appropriate for those preparing to become early childhood educators and for those preparing to teach subjects other than math in middle school.*

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

**Currently taught in workshop format.*

Prerequisite:

Mathematics 105 and 106.

Catalog Description:

Further topics in mathematics selected by the instructors to broaden the mathematical perspectives of early 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. *Appropriate for those preparing to become early childhood educators and for those preparing to teach subjects other than math in middle school.*

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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Mathematics 108
Au

5 credits

Number and Algebraic Structures for Middle School Teachers

Prerequisite:
Mathematics 150. Note: Open only to middle childhood majors.

Catalog Description:
Concepts of arithmetic and algebra, including induction, number systems, binary operations, combinatorial counting, and number theory. Generalized algebraic structures developed through number systems, matrices, and modulo arithmetic. An emphasis is placed on explanations and mathematical exposition.

Purpose of Course:
The purpose of the course is to prepare mathematics 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:
Mathematics 109

Text:
1) Algebra Connections: Mathematics for Middle School Teachers, by Ira Papick, Pearson, ISBN 0131449281
2) Course Notes

Topics List:
1. Number Systems and Induction
2. Division and Euclid's algorithm
3. More on number systems, fractions
4. Solving linear equations
5. The polynomial algebra underlying the decimal system
6. More on number systems, real numbers
7. Matrix arithmetic
8. Binomial theorem

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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:

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

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Topics List:

1. Definitions and Euclidean postulates
2. Measurement (also teaching measurement in middle school))
3. Congruence (also introducing congruence in middle school))
4. Similarity (informal approach and theoretical underpinnings)
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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Mathematics 110 **5 credits** **Algebraic Thinking and Probability for Middle School Teachers**
Au

Prerequisite:

Mathematics 108, 109, Stat 145.
Note: *Open only to middle childhood majors.*

Catalog Description:

Roles and representations of variables and formulas, functions and other relations, and methods of solving equations. Randomness, expected value, simulations, and binomial and geometric probabilities.

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:

Mathematics 111, 212

Text:

1) Course Notes
2) Mathematics Modeling for Today's Mathematics Classroom. Dossey, John, et al. (2002). Brooks/Cole.

Topics List:

1. Functions and their representations
2. Mathematical modeling
3. Difference equations, linear programming
4. Counting, permutations and combinations
5. Regression, arithmetic sequences, geometric sequences and series
6. Probability
7. Randomness, Monte Carlo methods
8. Data and curve-fitting

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Mathematics 111 **5 credits** **Concepts of Calculus for Middle School Teachers**
Wi

Prerequisite:

Mathematics 108, 109, 110.
Note: *Open only to middle childhood majors.*

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.

Text:

Under Consideration
Supplementary Text: Course Notes

Topics List:

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

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Mathematics 116 **5 credits** **Excursions in Mathematics**
Au*, Wi, Sp, Su

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

Prerequisite:

Mathematics 75 or 76 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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Topics List chosen from the following:

Graph theory
Graphs, Euler circuits, Hamilton circuits, the Traveling Salesman Problem, TSP algorithms, spanning trees, Kruskal's algorithm

Voting & apportionment
Preference ballots, methods of determining the winner of an election, apportionment and its paradoxes, a history of U.S. Congressional apportionment, the methods of Jefferson, Adams, and Webster

Patterns & growth
Sequences defined by recursion, the Fibonacci sequence, the golden ratio, arithmetic and geometric sequences, models of population growth: linear, exponential, and logistic

Symmetry
Rigid motions, symmetry, rosettes & friezes, rudiments of group theory

Counting & probability
Counting principles, permutations and combinations, multiplication rule, randomness, sample spaces & probability spaces

Fractals
Recursive definitions of fractals, standard examples (Koch snowflake, Sierpinski gasket et al), self-similarity, notions of fractional dimension

Linear programming
Mixture problems, examples in low dimension, the cornerpoint principle, algorithms

(Note that this topics list is too long for any single course. Each instructor will make a selection from it.)

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

Prerequisite:

Math 150, Course Code Level L, or Permission from 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 for whom the course is a requirement. The intent of the course is to introduce these students to the derivative and definite integral of single-variable functions, using rate of change and slope as a conceptual model for the derivative, and net change and area as a conceptual model for the definite integral. Emphasis will be placed on using these concepts to model and solve problems in the physical world. Algebraic, graphical, and tabular representations of these ideas will be used.

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 105 Mathematics Bldg.

Text:

Single Variable Calculus: Concepts and Contexts, by James Stewart (3rd Edition). Published by Cengage. ISBN: 0-534-41022-7.

Calculator:

A graphing calculator is required for this course. Most instructors will be familiar with the Texas Instrument TI-83, 83Plus, or 84. NOTE: Calculators with a Computer Algebra System such as the TI-89 or TI-92 will not be permitted in the course.

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Tentative Topics List (3rd Edition)

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 (If time permits)
- 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 (by slicing, of solids of revolution)
- 6.3: Arc Length (If time permits)
- 6.4: Average Value of a Function (If time permits)
- 6.5: Applications in Physics and Engineering (e.g., Moments and Center of Mass, Hydrostatic Force)
- If Time: Surface Area of Solids of Revolution

Brief Overview of Multivariable Calculus (If time permits)
- Partial Derivatives, Tangent/Normal Planes, Optimization
- Multiple Integrals, Volume, Center of Mass

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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, 1st OSU custom edition, by Barnett, Pearson, ISBN 055835176X (textbook ISBN 0558391028, MyMathLab Access Card ISBN 0321199901)

Topics List:

Sections	Topics
1.1, 1.2	Linear Equations and Inequalities; Graphs and Lines
2.1, 2.2	Functions, Graphs and Transformations
2.3	Quadratic Functions
4.1, 3.5(H)	Systems of Equations (Linear and Nonlinear)
2.4, 2.5	Exponential and Logarithmic Functions
3.1, 3.2	Simple, Compound and Continuous Compound Interest
3.3	Future Value of an Annuity; Sinking Fund
5.2(H)	Present Value
3.4	Present Value of an Annuity; Amortization

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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, 3rd OSU custom edition, by Barnett, Pearson, ISBN 0558351778

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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Topics List:

Sections	Topics
10.1	Limits
10.2	Continuity
10.3	Infinite Limits and Limits at Infinity
10.4	The Derivative
10.5	Basic Differentiation Properties
10.7	Marginal Analysis in Business and Economics
11.1	The Constant e and Continuous Compound Interest
11.2	Derivatives of the Exponential and Logarithmic Functions
11.3	Derivatives of Products and Quotients
11.4	The Chain Rule
11.5	Implicit Differentiation
12.1	First Derivative and Graphs
12.2	Second Derivative and Graphs
12.4	Curve-Sketching Techniques
12.5	Absolute Maxima and Minima
12.6	Optimization

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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, for Autumn 2009 only:

Introductory Mathematical Analysis, 2nd OSU custom edition, by Haeussler/Paul/Wood, Pearson, 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

New Text for Winter 2010.

Continued.

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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

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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 which involve solving linear and quadratic equations, system of equations, variation, trigonometry of acute angles, law of sines and cosines, vectors, and exponential and logarithmic equations.

Purpose of Course:

To help students make the transition from abstract mathematics to concrete applications, while while at the same time 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 (2009 – 2010), by Hungerford, Cengage ISBN 1424064619

Technology:

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

Continued:

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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

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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, rational, 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, Cengage, 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:

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152.02:

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
7.4	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

153.02:

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

254.02:

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

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Math 151.02, 152.02, 153.02, 254.02
Course Coordinator: I. Leary
2009-2010

Mathematics 152.01 **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 153.01

Text:

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

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

Continued:

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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

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Mathematics 153.01 **5 cr.** **Calculus and Analytic Geometry**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 152 (C- or better) or 161 or 161.01H.

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, Cengage, ISBN 0495416924

Alternate Text: Calculus: Early Transcendentals, 6th edition, by Stewart, Thomson, ISBN 0534393217

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Continued:

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

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Mathematics 161.01 Au
Mathematics 162.01 Wi
Mathematics 263.01 Sp

5 cr. Each

Accelerated Calculus with Analytic Geometry

Prerequisite:

Math 162.01: 161 or written permission of department.
Math 263.01: 162 or written permission of department.

Catalog Descriptions:

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

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

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

Purpose of Course:

The three-course sequence, 161.01-162.01-263.01, is equivalent in content to the four-course sequence 151.01-152.01.01-153.01-254.01. 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, 161.01 serves as a substitute for 151.01 and 152.01.01, 162.01 as a substitute for 153.01, and 263.01 substitutes for 254.01.

Follow-up Course:

Courses in differential equations or linear algebra, possibly 520H, if completed 345 concurrently with 263.

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Text:

Calculus: Early Transcendentals, Volume 1, 6th OSU custom edition, by James Stewart, Cengage, ISBN 1424064554. Volume 2 (ISBN-13: 9781424064571), for Math 162.01 and 163.

Alternate Text: Calculus: Early Transcendentals, 6th edition, by James Stewart, Thomson, ISBN 0534393217.

NOTE: The textbook for the Math 161.01 sequence and Math 151.01 sequence is the same. The text for the 161.01H sequence is different.

Topics:

161.01: 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.

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

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

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Mathematics 161.01H Au
Mathematics 162.01H Wi
Mathematics 263.01H Sp

5 cr. Each

Accelerated Calculus with Analytic Geometry

Prerequisite:
161.01H - Credit for Math 151, or satisfactory score on Department Qualifying Exam.
162.01H - 161.01H with a grade of C or better or written permission of Honors Committee chair.
263.01H - 162.01H with a grade of C or better or written permission of Honors Committee chair.

Catalog Description:
The catalog descriptions for 161.01H, 162.01H, and H163 are the same as those for 161.01, 162.01, and 263.01 (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 161.01, 162.01, 263.01; 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 161.01H is a substitute for 151.01 and 152.01, 162.01H for 153.01, and 263.01H for 254.01.

Follow-up Course:
After completing 263.01H concurrently with 345, students will be ready for Math 520H, 521H and 522H (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 161.01 sequence and Math 151.01 sequence are not the same as 161.01H.

Topics:
161.01H. 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.
162.01H. 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.
263.01H. 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.

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Mathematics 161.02 Au
Mathematics 162.02 Wi
Mathematics 263.02 Sp

5 cr.

Accelerated Calculus with Analytic Geometry I, II, III

Prerequisite:

Students are individually chosen by the College of Engineering.
Math 161.02: Course code L placement and high school calculus.
Math 162.02: 161.02 or written permission of department.
Math 263.02: 162.02 or written permission of department.

Catalog Description:

161.02:
Functions, limits and continuity, derivatives, applications of the derivative, L'Hopital's Rule, the integral, techniques of integration, applications of the integral.

162.02:
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

263.02:
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; 161A, 162A, and 263A in 04-05 and 161.02, 162.02 and 263.02 in 2009.

Text:

Calculus/Early Transcendentals, Volumes 1 & 2, 6th Edition, by Stewart, Thomson,
ISBN-13: 9781424064557, ISBN-13: 9781424064571

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.

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Mathematics 187.01H **2 cr. Each** **Advanced Problem Solving**
Mathematics 487H
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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Mathematics 190H	**Au**	**5 cr. Each**	**Elementary Analysis I**
Mathematics 191H	**Wi**		**Elementary Analysis II**
Mathematics 264H	**Sp**		**Elementary Analysis III**

Prerequisite:
190H - Permission of department
191H - A grade of C or better in 190H
264H - A grade of C or better in 191H

Catalog Descriptions:
190H: The first of an enriched honors calculus sequence designed to introduce students to the mathematical underpinnings of analysis.

191H: Continuation of 190H.

264H: Continuation of 191H; 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 151.01, 152.01, 153.01, 254.01, and 551. 190H - 191H 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 520H, 521H, 522H

Texts vary, for example:
190H, 191H: Calculus, 4rd edition, by Spivak, Publish or Perish, ISBN 0914098918
264H: Advanced Calculus, by Folland, Prentice-Hall, ISBN 0130652652
264H: Advanced Calculus of Several Variables, Edwards, Jr. (used Sp05)
264H: Vector Calculus, 4th edition, Marsden/Tromba (used Sp00, Sp03, Sp09)
264H: Advanced Calculus, 3rd edition, Buck (used Sp02)

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Topics:

190H - 191H:

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.

264H:

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

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Mathematics 212 **5 credits** **History of Mathematics**
Sp **for Middle School Teachers**

Prerequisite:

Math 110 and 111. Open only to middle childhood majors.

Catalog Description:

Historical development of concepts appropriate to middle childhood mathematics. A capstone course to bring together topics discussed in 108, 109, 110, 111 and Statistics 145.

Purpose of Course:

The general goal of this course is to prepare you to become teachers of middle school students. Knowing the mathematics for yourself is not the same as knowing the math for teaching.

Text:

Math through the Ages: A Gentle History for Teachers and Others (Expanded Edition), by Berlinghoff, W. P. & Gouvea, F.Q. (2004). Oxton House Publishers, Mathematical Assn. of America.

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Topics List:

1 History of whole numbers and fractions
2 The Story of π
3 Origins of linear thinking: Solving First Degree Equations
4 Greek Mathematics
- The Pythagorean Theorem
- Euclid's Plane Geometry
- The Platonic Solids

5 Mathematics in India
- The Story of Zero
- Negative Numbers
- Sine and Cosine

6 Arabic mathematics
- Quadratic Equations
- Beginnings of algebra

7 Medieval Europe
- Reading & Writing Arithmetic: Where the Symbols Came From
- Solving Cubic Equations

8 The 15th and 16th Centuries
- Projective Geometry
- Algebra Comes of Age

9 Coordinate Geometry
10 Non-Euclidean Geometries
11 Calculus and Applied Mathematics
12 Rigor and Professionalism
13 Abstraction, Computers and New Applications

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Mathematics 254.01 **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, 6th OSU custom edition, by James Stewart, Thomson, ISBN 0495416924.

Alternate Text: Calculus: Early Transcendentals, 6th edition, by James Stewart, Thomson, ISBN 0534393217.

Continued.

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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)

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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:

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

Topics List:

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	

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	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	
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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Math 255
Course Coordinator: W. Luo
2009-2010

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:

Lecture Notes, Math Print Shop

Other useful references:

The Fundamentals of Higher Mathematics, by Falkner
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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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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Mathematics 415.01, 415.02 **4 cr.** **Ordinary and Partial Differential Equations**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 254

Catalog Description:

Ordinary, partial, linear and nonlinear differential equations; Fourier series, boundary value problems; and system of first order equations.

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:

Elementary Differential Equations and Boundary Value Problems, 8th OSU Custom Edition, by Boyce, Wiley, ISBN 9780470438862

-or-

Dr. Baker's lecture notes, Math Print Shop

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

Continued:

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2.6	Exact equations	
3.1	Homogeneous equations with constant coefficients	
		7 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	
3.8	Mechanical and electrical vibrations	
3.9	Forced vibrations	
		6-7 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

7.1	Systems of first order equations: Linearization at equilibrium – the problem of stability	
7.2-7.3	Matrices, eigenvalues, eigenvectors, phase plane examples in 2-D	
7.4-7.5	Homogeneous linear systems with constant coefficients	
7.6	Complex eigenvalues	
		5-6 days

* This section 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

Students have virtually no background in linear algebra. Consequently, it is best to confine the material in Sections 7.1-7.6 to 2x2 or 3x3 matrices at most.

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

Prerequisite:

Mathematics 264H 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 parametric form of length, area and volume formulas from calculus
II. Review of Euclid's postulates and Euclidean geometry (resurrect high school geometry as the unique complete, flat, 2-dimensional geometry)
III. Cross-ratio, a projective invariant
IV. Rigid motions, linear algebra, linear fractional transformations
V. Intuitive idea of Riemannian geometry (consider 2-dimensional geometries which are possibly 'curved')
VI. Spherical geometry (a positively curved, complete homogeneous, 2-dimensional geometry)
VII. Rigid motions in spherical geometry (enough of these is what makes these geometries 'homogeneous')
VIII. Length and area in spherical geometry
IX. Hyperbolic geometry (a negatively curved, complete homogeneous, 2-dimensional geometry)
X. Rigid motions in hyperbolic geometry (enough of these is what makes these geometries 'homogeneous')
XI. Length and area in hyperbolic geometry

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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, Pearson, 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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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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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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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.

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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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Mathematics 520H	**Au**	**5 cr. Each**	**Linear Algebra**
Mathematics 521H	**Wi**		**Differential Equations**
Mathematics 522H	**Sp**		**Complex Analysis**

Prerequisites:

520H: 263.01H or 264H
521H: 520H
522H: 521H
Or written permission of Honors Committee chairperson.

Catalog Descriptions:

520H: Vector spaces, linear transformations, systems of equations, determinants, eigenvalues, spectral theorem, Cayley-Hamilton theorem.
521H: Ordinary, linear and nonlinear differential equations, existence and uniqueness theorems, Fourier series, boundary value problems, systems, Laplace transforms, phase space, stability and periodic orbits.
522H: 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 255.01 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.

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Texts:

Vary, for example:

Autumn: 520H
Linear Algebra: An Introductory Approach, 4th Revised Edition, by Curtis, Springer, ISBN 387909923 (used Au03-Au09)
Linear Algebra and Its Applications, by Strang (used 2000)

Winter: 521H
An Introduction to Ordinary Differential Equations, by Coddington, Dover, ISBN 0486659429 (used Wi09-Wi09)
Differential equations with Applications & Historical Notes, 2nd Edition, by Simmons (used Wi05)
Nonlinear Dynamics and Chaos, by Strogatz (used Wi01)

Spring: 522H
Elementary Theory of Analytic Functions of One or Several Complex Variables, by H. Cartan, Dover, ISBN 0486685438 (used Sp07-Sp09)
Complex Analysis, 2nd edition, by Bak-Newman (used 2005-2006)
Complex Analysis with Applications, by Silverman (used Sp03)

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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, ISBN 9780387979748.

Topics:

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

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Mathematics 531H **5 credits** **Rigorous Probability**
Au

Prerequisite:

Math 264H

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.

Texts:

Heads and Tails. An Introduction to Limit Theorems in Probability, E. Lesigne, AMS, ISBN 0821837141

Other Suggested Texts:

Elementary Probability Theory with Stochastic Processes, Kai Lai Chung
Probability Theory - A Concise Course, Y. Rosanov
The Pleasures of Probability, Richard Isaac
Statistical Inference in Probability, Analysis and Number Theory, M. Kac.

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Mathematics 532 **3 cr.** **Mathematical Foundations**
Sp **of Actuarial Science**

Prerequisite:

Mathematics 530 or Statistics 420 or Mathematics 531H, 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.

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Mathematics 540H	**Wi***	**5 cr.**	**Geometry and Calculus in Euclidean Spaces and on Manifolds I & II**
Mathematics 541H	**Sp***		

** Offered odd numbered years*

Prerequisite:

Mathematics 263.01H or 264H, 520H, 521H, 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 540H, 541H sequence 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 541H.

Texts vary, for example:

Differential Geometry of Curves and Surfaces, DoCarmo, (used 2003-2009)
Elements of Differential Geometry, R. Milman and G. Rarker
Elementary Topics in Differential Geometry, Thorpe (used 2005)
A First Course in Geometric Topology and Differential Geometry, E. Bloch (used 2007)

Topics for 540H-541H:

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

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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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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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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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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.

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 Chapter 6	Arc length, line integrals, surface area, Integrals Conservative vector fields, Green's Theorem, Divergence Theorem, Stokes' Theorem	6 weeks

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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Mathematics 556	**Wi**	**3 cr.**	**Differential Equations I**
Mathematics 557	**Sp**		**Differential Equations II**

Prerequisite:

Mathematics 255 or equivalent

Catalog Description:

556: Qualitative theory of ordinary differential equations, including phase plane analysis, stability, oscillations and bifurcations, with applications to the biological and physical sciences.

557: An introduction to the basic properties of partial differential equations and to the techniques for analyzing them.

Purpose of Courses:

This sequence is designed to introduce students to mathematical methods for analyzing both ordinary and partial differential equations. Students will also learn how to use these methods to study mathematical models that arise in the applied sciences.

Text:

556: Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, by Steven Strogatz, Perseus Books Group. ISBN 0-7382-0453.

557: Partial Differential Equations: An Introduction, by Walter Strauss, ISBN 0470054567.

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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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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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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, Cengage, ISBN 0534998453

Continued:

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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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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 with Applications, 7th edition, by S. Leon, Pearson, ISBN 0131857851

Linear Algebra Labs with Matlab, 3rd edition, by Hill/Zitarelli, Pearson, ISBN 0131432745

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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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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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, 5th edition, Niven/Zuckerman/Montgomery (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.

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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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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

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Mathematics 576H Wi* **5 cr. each** **Number Theory**
Mathematics 577H Sp* **Through History I, II**

**Offered even numbered years*

Prerequisite:

576H: 190H, 191H, and 520H, or written permission of Honors Committee chair.
577H: 576H or written permission of Honors Committee chair.

Catalog Description:

576H:
The integrated honors sequence 576H-577H includes elementary analytic and algebraic number theory and traces its unifying role in development of mathematics through history.

577H:
Continuation of 576H.

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.

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Suggested Topics List:

576H:

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.

577H:

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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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

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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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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, 571 or 520H and Mathematics 345.
581: Mathematics 580 or 590H
582: Mathematics 581 or 591H

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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Mathematics 585 **3 credits** **Introduction to Coding Theory and Design Theory**
Au

***Cancelled for Au09**

Prerequisite or Concur:

Math 582 or 592H, or permission of instructor.

Catalog Description:

Introduction to error-correcting codes and block designs, and their applications.

Purpose of Course:

Coding theory and design theory are important topics at the crossroads of mathematics, statistics, electrical engineering, and computer science. Codes and designs are applied, among others, in telecommunication (cell phones, data modems, internet connections), compact discs, statistical experiments, and linear regression models.

Coding theory and design theory are closely related. Designs are used to construct efficient error-correcting codes and, conversely, codes associated with designs are used to tackle some of the most difficult problems in design theory.

The objective of the course is to acquaint the students with the basic notions and with some applications of these important areas of applied mathematics.

Text:

A First Course in Coding Theory by Raymond Hill, Oxford University Press, 1986

Topics:

Basic concepts of error-correcting codes
Perfect codes, Hamming and Golay codes
Linear codes and cyclic codes, BCH codes
Balanced incomplete block designs, finite projective geometries,
Latin squares
Reed-Muller codes
Applications of codes and designs

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Mathematics 588 **4 cr.** **Practicum in Actuarial Science**
Sp

Prerequisite:

3rd year standing and completion of second writing course. Open only to actuarial science majors.

Catalog Description:

Presentations by practicing actuaries on topics drawn from their fields of expertise; oral presentations by students on selected topics in actuarial science.

Purpose of Course:

To introduce students to actuarial practice and hone their written and oral communication skills. We expect that this course will serve as the third writing course for the actuarial science major.

Text:

No textbook is required. Course material will be prepared by the lecturers.

Topics:

Various topics in life, health, and property and casualty insurance, pension and benefits consulting, chosen by the visitors.

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Mathematics 590H	**Au**	**5 cr. Each**	**Algebraic Structures I**
Mathematics 591H	**Wi**		**Algebraic Structures II**
Mathematics 592H	**Sp**		**Algebraic Structures III**

Prerequisite:

590H: 520H with a grade of C or better, or written permission of Honors Committee Chair
591H: 590H with a grade of C or better, or written permission of Honors Committee Chair
592H: 591H 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 590H, 591H, 592H sequence substitutes for the sequence 580, 581, 582.

Text:

Vary, for example:
Abstract Algebra, by D. Dummit and R. Foote (2004-2007)
Algebra, by M. Artin
Topics in Algebra, by I. Herstein

Suggested Topics:

590H:

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.

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591H:

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.

592H:

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 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, 4th Edition, by Strang, Cengage, ISBN 978003010568 (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

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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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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 603.02

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

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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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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

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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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Mathematics 615	**Au**	**3 cr.**	**Applied Differential Equations I**
Mathematics 616	**Wi**	**3 cr.**	**Applied Differential Equations II**
Mathematics 617	**Sp**	**3 cr.**	**Applied Differential Equations III**

Prerequisite:

Mathematics 255 and linear algebra.

Catalog Description:

615: An applied course emphasizing modeling by differential equations of physical and biological processes. Topics include explicit solutions, existence and uniqueness, n-dimensional linear ODE systems, geometric theory, bifurcation analysis.

616: An introduction to the basic types of partial differential equations and their solutions, including the methods of separation of variables and Fourier transform. Applications to problems in physics and biology.

617: Topics in applied ODEs and PDEs. Possible topics include solution of the Dirichlet problem in general domains, integral equations, nonlinear PDEs, chaotic dynamics, singular perturbations.

Purpose of Courses:

This sequence provides students with an understanding of how ordinary and partial differential equations are derived as mathematical models as well as how these systems may be analyzed and interpreted within the context of applications. The courses are designed around examples in mechanics and biology, emphasizing how the mathematical development and bifurcation theory helps one gain better understanding of the physical and biological models.

Text:

615: Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering, Steven Strogatz. Westview Press, 2001.

616: Partial Differential Equations: Analytical and Numerical Methods, Mark S. Gockenbach. SIAM, 2002.

617: Text will be chosen by instructor.

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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, 4th Edition, by Samuel A. Broverman, ASA, Ph.D., Actex Publications.
- Derivatives Markets, 2nd Edition, by Robert L. McDonald, Addison Wesley.

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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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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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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.

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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.

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Text:
Topology, 2nd Edition, by Munkres, Pearson, ISBN 0131816292

Other 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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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.

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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.

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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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