# Department of Mathematics
# The Ohio State University

## 2004-2005 Mathematics Courses

| Course Number | Course Title |
| --- | --- |
| 50 | Pre-College Mathematics I |
| 75 | Pre-College Mathematics II |
| 76 | Reentry Precollege Math |
| 103 | Enrichment of Basic College Mathematics |
| 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 |
| 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 |
| 140 | Calculus with Review I |
| 141 | Calculus with Review II |
| 148 | Algebra and Trigonometry and Their Applications |
| 150 | Elementary Functions |
| 151 | Calculus and Analytic Geometry |
| 152 | Calculus and Analytic Geometry |
| 153 | Calculus and Analytic Geometry |
| 151A | Calculus and Analytic Geometry |
| 152A | Calculus and Analytic Geometry |
| 153A | Calculus and Analytic Geometry |
| 254A | Calculus and Analytic Geometry |
| 151C | Calculus and Analytic Geometry |
| 152C | Calculus and Analytic Geometry |
| 153C | Calculus and Analytic Geometry |
| 254C | Calculus and Analytic Geometry |
| 161 | Accelerated Calculus with Analytic Geometry |
| 162 | Accelerated Calculus with Analytic Geometry |
| 263 | Accelerated Calculus with Analytic Geometry |
| 161A | Accelerated Calculus with Analytic Geometry I |
| 162A | Accelerated Calculus with Analytic Geometry II |

| Course Number | Course Title |
|---|---|
| 263A | Accelerated Calculus with Analytic Geometry III |
| 161H | Accelerated Calculus with Analytic Geometry |
| 162H | Accelerated Calculus with Analytic Geometry |
| 263H | Accelerated Calculus with Analytic Geometry |
| 187H | Advanced Problem Solving |
| 487H | Advanced Problem Solving |
| 190H | Elementary Analysis I |
| 191H | Elementary Analysis II |
| 264H | Elementary Analysis III |
| 254 | Calculus and Analytic Geometry IV |
| 255 | Differential Equations and Their Applications |
| 255C | Differential Equations and Their Applications |
| 345 | Foundations of Higher Mathematics |
| 366 | Discrete Mathematical Structures I |
| 414 | Group Studies: Differential Equations for Engineering Applications |
| 415 | Ordinary and Partial Differential Equations |
| 415C | Ordinary and Partial Differential Equations |
| 504 | History of Mathematics |
| 507 | Advanced Geometry |
| 512 | Partial Differential Equations and Boundary Value Problems |
| 513 | Vector Analysis for Engineers |
| 514 | Complex Variables for Engineers |
| 520H | Linear Algebra Differential Equations Complex Analysis |
| 521H | Linear Algebra Differential Equations Complex Analysis |
| 522H | Linear Algebra Differential Equations Complex Analysis |
| 530 | Probability |
| 532 | Mathematical Foundations of Actuarial Science |
| 540H | Geometry and Calculus in Euclidean Spaces and on Manifolds I |
| 541H | Geometry and Calculus in education Spaces and on Manifolds II |
| 547 | Introductory Analysis I |
| 548 | Introductory Analysis II |
| 549 | Introductory Analysis III |
| 551 | Vector Analysis |
| 552 | Introduction to the Theory of Functions of a Complex Variable |
| 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 |

| Course Number | Course Title |
| --- | --- |
| 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 |
| 588 | Practicum in Actuarial Science |
| 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, B |
| 618 | Theory of Interest |
| 630 | Actuarial Mathematics I |
| 631 | Actuarial Mathematics II |
| 632 | Actuarial Mathematics III |
| 650 | Principles of Mathematical Analysis |
| 651 | Introduction to Real Analysis I |
| 652 | Introduction to Real Analysis II |
| 653 | Introduction to Real Analysis III |
| 655 | Elementary Topology I |
| 656 | Elementary Topology II |
| 657 | Elementary Topology III |
| 665 | Modern Mathematical Methods in Relativity Theory I |
| 666 | Modern Mathematical Methods in Relativity Theory I |
| 670 | Algebra I |
| 671 | Algebra II |
| 672 | Algebra III |
| 701 | Mathematical Principles in Science III: Calculus of Variations & Tensor Calculus |

**Mathematics 050**                     **5 cr.**                    **Precollege Mathematics I**
A, W, Sp, Su

## Prerequisite:

Course Code T on Math Placement Test.

## Catalog Description:

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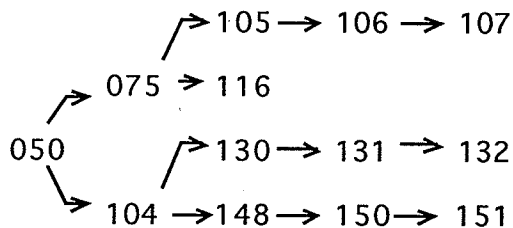
## Purpose of Course:

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

## Follow-up Course:

Math 075 or Math 104

## Sequencing Chart:

```
                    ╱➤105 ──➤ 106 ──➤ 107
                   ╱
          ╱➤ 075  ➤ 116
         ╱
   050          ╱➤130 ──➤ 131 ──➤ 132
         ╲     ╱
          ➤ 104 ──➤148 ──➤ 150 ──➤ 151
```

## Text:

Beginning Algebra by K. Elayn Martin-Gay, 4th ed.

(Over for Topics List and Sample Syllabus)

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

## Topics List & Sample Syllabus

| Sections | Topics |
|---|---|
| 1.1-1.8 | **REVIEW OF REAL NUMBERS** |

**REVIEW OF REAL NUMBERS**
Symbols and Sets of Numbers
Fractions
Exponents and Order of Operations
Introduction to Variable Expressions and Equations
Adding Real Numbers; Subtracting Real Numbers
Multiplying and Dividing Real Numbers

2.1-2.6    **EQUATIONS, INEQUALITIES, AND PROBLEM SOLVING**
Simplifying Algebraic Expressions
The Addition and Multiplication Property of Equality
Solving Linear Equations
An Introduction to Problem Solving
Solving Linear Inequalities

*Review and 1st Midterm*

Formulas, Percent and Problem Solving
Further Problem Solving

1.9, 3.1-3.6    **GRAPHING**
Reading Graphs
The Rectangular Coordinate System
Graphing Linear equations
Intercepts; Slope; Graphing Linear Inequalities
Point-slope formula

5.1-5.6    **EXPONENTS AND POLYNOMIALS**
Exponents
Addition and Subtraction of Polynomials
Multiplication of Polynomials, Special Products

*Review and 2nd Midterm*

Negative Exponents and Scientific Notation
Division of Polynomials

6.1-6.6    **FACTORING POLYNOMIALS**
The Greatest Common Factor and Factoring by Grouping
Factoring Trinomials
Factoring Binomials
Choosing a Factoring Strategy

*Review and 3rd Midterm*

Solving Quadratic Equations by Factoring
Quadratic Equations and Problem Solving

*Review and Final Exam*

**Mathematics 075**                    **4 cr.**                    **Precollege Mathematics II**
**A, W, Sp, Su**

## Prerequisite:

Mathematics 050, or Course Code S or R on Math Placement Test.

## Catalog Description:

Systems of equations, arithmetic of polynomials, factoring, fractional   equations, variation, quadratic equations, functions, graphs, right angle trigonometry.
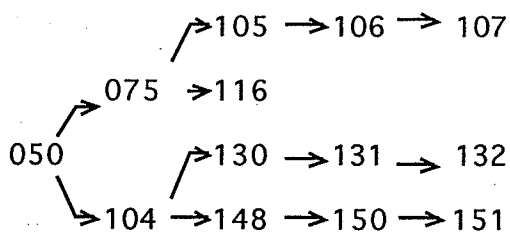
## Purpose of Course:

To meet the needs of students entering the University with Course Code S on Math Placement Test, or with credit for 050. Completion of Math 075 is required for entry into numerous degree granting colleges; however, credit for 075 will not count toward graduation in any degree granting program. It is designed for students continuing in Math 105 or 116.

## Follow-up Courses:

Math 104 for students switching to science, computer science, business  or engineering curriculum.

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

## Sequencing Chart:

```
                    ↗105 →106 → 107
                  /
              ↗075 →116
            /
      050
            \        ↗130 →131 → 132
             \     /
              ↘104 →148 →150 →151
```

## Text:

Beginning Algebra, (4th ed.) Martin-Gay

(Over for Topics List & Sample Syllabus)

## Topics List & Sample Syllabus

| Sections | Topics |
|---|---|
| 6.1-6.5 | **FACTORING POLYNOMIALS** |

6.1-6.5 **FACTORING POLYNOMIALS**
 Greatest common factor and factoring by grouping
 Factoring trinomials
 Factoring binomials
 Solving quadratic equations by factoring

7.1-7.5 **RATIONAL EXPRESSIONS**
 Simplifying rational expressions
 Multiplying and dividing rational expressions
 Adding and subtracting rational expressions
 Least common denominator
 Solving equations containing rational expressions

*Review and first midterm*

7.6 **RATIONAL EXPRESSIONS**
 Proportion and problem solving with rational expressions

3.4-3.6 **GRAPHING**
 Slope and rate of change
 Slope-intercept form
 Point-slope form

4.1-4.4 **SOLVING SYSTEMS OF LINEAR EQUATIONS**
 Solving systems of linear equations by graphing
 Solving systems of linear equations by substitution
 Solving systems of linear equations by addition
 Systems of linear equations and problem solving

*Review and second midterm*

8.1-8.7 **ROOTS AND RADICALS**
 Introduction to radicals
 Simplifying radicals
 Adding and subtracting radicals
 Multiplying and dividing radicals
 Solving equations containing radicals
 Radical equations and problem solving
 Rational exponents

9.1-9.3 **QUADRATIC EQUATIONS**
 Solving quadratic equations by the square root method
 Solving quadratic equations by completing the square
 Solving quadratic equations by the quadratic formula

*Review and third midterm*

*Review and final exam*

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Course Coordinator:
Brian McEnnis
2004-2005

## Prerequisite:

At least one year of high school algebra, out of high school for 5 or more years at time of university enrollment, no formal training in Math in the past 5 years, and written permission of the Department of Mathematics.

## Catalog Description:

Arithmetic of signed numbers, exponents, linear equations, systems of equations, arithmetic of polynomials, factoring, fractional equations, variation, quadratic equation, functions, graphs.
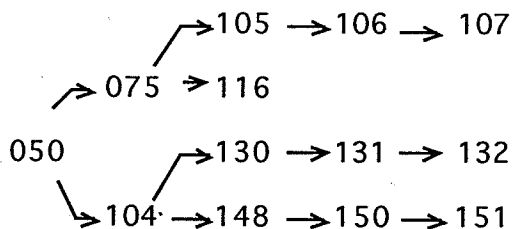
## Purpose of Course:

This course is designed to meet the needs of returning, non-traditional students. It can be considered a substitute for 050 and 075 and satisfies the prerequisites for Math 104, 105, and 116. Completion of Math 076 is sufficient for entry into numerous degree granting colleges; however, credit for 076 will not count toward graduation in any degree granting program.

## Follow-up Courses:

Math 104 for students in science, computer science, business, or engineering.
Math 105 for students in some education and human ecology programs.
Math 116 for students in liberal arts.

## Sequencing Chart:

```
                    ┌→105 →106 → 107
                   /
            ┌→ 075  ⤳116
            
    050           ┌→130 →131 → 132
            \     /
             ⤳104 →148 →150 →151
```

## Text:

Algebra, An Approach for Success, Damarin and Leitzel, (Burgess International Group, Inc.)
Chapters 1 - 6, 8 - 11

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## Topics List

1. Arithmetic of signed numbers

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

3. Word problems

4. Solving linear equations and inequalities

5. Graphs of equation

6. Linear equations
    standard form; slope - intercept form

7. Parallel and perpendicular lines

8. Systems of linear equations

9. Polynomials
    addition, subtraction, multiplication
    division with quotient and remainder

10. Factoring polynomials
    common monomial factor
    quadratics
    by grouping

11. Rational roots and factors

12. Fractional exponents

13. Simplifying radical expressions

14. Solving quadratic equations
    by factoring
    by completing the square
    use of quadratic formula

15. Negative exponents

16. Simplifying rational expressions

17. Solution of fractional equations and applications

Course Coordinator:
Gloria Woods
2004-2005

**Mathematics 103          2 cr.          Enrichment of Basic College Mathematics**
**Au**

## Catalog Description:

Supplement to Math 104 using small-group student-centered active learning to create a new paradigm for learning mathematics

## Prerequisite:

New first quarter freshman, no math admission condition (i.e. 3 or more units of college prep math), optional for Math Placement T (may take 050 or 103/104) and Math Placement S (may take 050, 075, or 103/104); Concurrent enrollment in Math 104 required.

## Purpose of Course:

This course offers an opportunity for at-risk NFQF [Math Course Code T and S] to develop the skills needed to learn Math. Enrollment in 103 enables code T students to concurrently enroll in Math 104, in place of registration in Math 050. Math 103 was offered in Au 94, Au 95, Au 96, and Au 97 under the Math 194A course number.

## Follow-up course:

Students in 103 who also successfully complete 104 are then eligible for 116, 130 or 148.

## Text:

Materials used parallel the content of Math 104 while enhancing students' ability to "process" and "strategize" the mathematics.

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Course Coordinator:
Harry Allen
2004-2005

**Mathematics 104**                   **5 cr.**                 **Basic College Mathematics**
**A, W, Sp, Su**

## Prerequisite:

Mathematics 050, or 075, or Course Code R on Math Placement Test. Not open to students with credit for 116, 130, or 148.

## Catalog Description:

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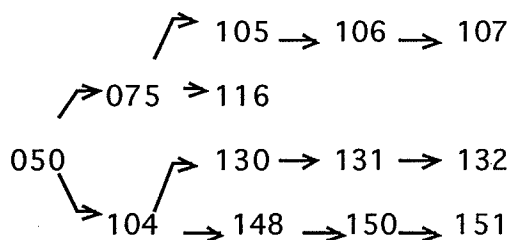
## Purpose of Course:

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

## Follow-up Course:

Math 130 or 148.

## Sequencing Chart:

```
                   /> 105 —> 106 —> 107
              />075  >116
       050          /> 130 —> 131 —> 132
           \      /
            >104 —> 148 —>150—> 151
```

## Text:

Intermediate Algebra for The Ohio State University; Hall/Mercer. ISBN 0-073-10932-0. This is a custom version of the standard Hall and Mercer Beginning and Intermediate Algebra text.

(Over for Topics List and Sample Syllabus)

## Topics List & Sample Syllabus

| Section | Topics |
| --- | --- |
| 3.3 | Solving Systems of Equations Graphically and Numerically |
| 3.4/3.5 | Solving Systems Using the Substitution and Addition Methods |
| 3.6 | Applications of Systems |
| 4.1/4.2 | Linear Inequalities |
| 4.3 | Compound Inequalities |
| 4.4 | Absolute Value Equations and Inequalities |
| 6.1 | Functions and Representation of Functions |
| 6.2 | Linear and Absolute Value Functions |
| 6.3 | Quadratic, Square Root, Cubic, and Cube Root Functions |

*Review and Exam 1*

| | |
| --- | --- |
| 6.4 | Horizontal and Vertical Translations |
| 6.7 | Linear Factors of Polynomials and Zeros |
| 7.1/7.2 | Factoring |
| 7.3/7.4 | Special Forms and General Factoring Strategy |
| 7.5 | Solving Equations by Factoring |
| 8.1 | Radicals |
| 8.2 | Addition and Simplification of Radicals |
| 8.3 | Multiplication and Division of Radicals |

*Review and Exam 2*

| | |
| --- | --- |
| 8.4 | Complex Numbers |
| 8.5 | Quadratic Equations and Inequalities |
| 8.6 | Equations with Radicals |
| 8.7 | Applications of Quadratic Equations |
| 9.1 | Rational Functions and reducing Rational Expressions |
| 9.2/9.3 | Operations on Rational Expressions |
| 9.4 | Simplifying Complex Rational Expressions |
| 9.5 | Solving Equations Containing Rational Expressions |

*Review and Exam 3*

| | |
| --- | --- |
| 9.6 | Applications Yielding Equations with Fractions |

Course Coordinator:
David George
2004-2005

| Mathematics 105 | 5 cr. | Fundamental Mathematics |
| A, W | | Concepts for Teachers I |

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

## Prerequisite:

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

## Catalog Description:

Development of basic ideas of arithmetic, algebra, and geometry as appropriate for teachers.

## Purpose of Course:

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

## Follow-up Course:

Math 106

## Text:

Mathematics for Elementary Teachers, 6th Ed., Musser & Burger; (lecture/recitation format)
OSU Math 105 Supplements/Labs

Published notes (workshop format)

# Topics List for Math 105

## I. Foundations
   A. Sets
   - what is a set: notation, extension property; Venn diagrams
   - subsets, unions, intersections, complements

   B. Logic
   - informal logic; formal logic; and truth tables and deduction

   C. Operations (see Whole Numbers, below)

## II. Whole Numbers and Their Properties
   A. Counting
   - one-to-one correspondence; inclusion-exclusion; cartesian products

   B. Factors
   - prime numbers, unique prime factorization, counting factors
   - LCM: how to obtain it; properties of the LCM
   - GCD: how to obtain it; properties of the GCD

   C. Negative Numbers
   - interpretation and rules for manipulation

   D. Properties of Operations
   - abstract operations: commutativity, associativity, identities, inverses
   - properties (and consequences) of: addition, multiplication, subtraction, and division
   - distributivity

   E. Place Value
   - how our numeration system works and other bases
   - algebraic representation of numbers in terms of their digits
   - negative place value and decimals (see Decimals, below)

   F. Common Algorithms
   - understanding algorithms; justification of addition, multiplication, subtraction, division

## III. Division and Fractions
   A. Division
   - inverse of multiplication, repeated subtraction, division algorithms and fractions.

   B. Ratio and Proportion
   - proportionality word problems; recognizing given data in terms of proportion
   - cross-multiplication and its justification

   C. Fractions
   - models of fractions; equivalent fractions and cross-multiplication; mixed vs. improper fractions
   - adding and subtracting fractions; multiplication and division of models and procedures.

   D. Decimals
   - place value; terminating decimals to fractions; classification of fractions as terminating or repeating decimals

   E. Scientific Notation
   - definition and conversion; estimation of physical qualities, approximate computation in scientific notation, and logarithmic scale (intro)

   F. Percentages
   - representation as a fraction or decimal; percentage increase or decrease

## IV. General Skills and Attitudes
   A. Problem Solving Strategies
   - trial and error; reducing the problem; numbers instead of variables; harnessing physical intuition

   B. Generalization and Abstraction
   - observing patterns; expressing observations; using variables to express and justify observations; broadening the scope

   C. Word Problems
   - understanding what is asked; unambiguous usage of variables; units; writing equations

   D. Broader Context
   - NCTM Standards for active learning, justification/proof, verbalizing; articulate and grammatical mathematical expression; argumentation

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

### Prerequisite:

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

### Catalog Description:

Continuation of 105.

### Purpose of Course:

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

### Follow-up Course:

Math 107

### Text:

Mathematics for Elementary Teachers, 6th ed., Musser & Burger. (lecture/recitation format)
OSU Math 106 Supplements/Labs

Published Notes (workshop format)

(over for Topics List)

# Topics List for Math 106

I. Length
   A. Measurement
- need for standard units; units and comparison; successful measurement

   B. Length and Distance
- length of a curve; distance in cartesian coordinates

   C. Behavior under Scaling and Change of Units

II. Area
   A. Defining Area
- conservation of area; comparing by dissecting and rearranging pieces; areas of irregular shapes; units of area; surface area

   B. Area Formulae
- rectangles; triangles; justification of formulae (parallelogram/trapezoid/circle); applications

   C. Behavior under Scaling and Change of Units
- proportionality to the square; two-dimensionality; independence of area and perimeter

III. Volume
   A. Defining Volume
   B. Prisms and Cylinders
- product formulae; right vs. oblique cylinders; pyramids and cones

   C. Behavior under Scaling and Change of Units
- proportionality to the cube; three-dimensionality; independence of volume and surface area

IV. Angle
   A. Defining and Measuring Angles
- using a protractor; alignment and orientation; units of angle

   B. Summing Angles
- adding adjacent angles; summing angles of a triangle; summing interior angles of a polygon

   C. Behavior under Scaling and Change of Units
- zero-dimensionality; independence of angle from linear measure of subtended chord; similarity; applications

V. Euclidean Geometry
   A. Axiomatic Reasoning
- Euclid's axioms; rigidity; proofs of some simple facts; motivation for Euclidean rigor

   B. Constructions with Straightedge and Compass
- relation to the axioms; basic constructions; proving your construction works

   C. New Proofs of Old Formulas
- rigorizing proof of area formulae; Pythagorean theorem

VI. Symmetry and Rigid Motion
   A. Rigid Motions
- reflections, rotations, translations; composing rigid motions

   B. Symmetry of Plane Figures
- reflections and lines of symmetry; rotations and centers of symmetry; finding all symmetries

   C. Tesselations and Their Symmetries
- translation symmetry; wallpaper patterns; classification of regular/semi-regular tesselations

   D. Three-Dimensional Shapes
- Platonic solids; planes of reflection; axes of rotation; symmetries of regular and other polyhedras

VII. General Skills
   A. Spatial Imagination
   B. Drawing and Sketching
   C. Vocabulary
   D. Broader Context: Role of Geometric Intuition in Mathematical Concept Formation

**Mathematics 107**
**Sp**

5 cr.

**Topics in Mathematics**
**For Elementary Teachers**

## Prerequisite:

Mathematics 106

## Catalog Description:

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

## Purpose of Course:

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

(over for Topics List)

## Topics List

I.  Combinatorics
    A. Cartesian Products and Power Sets (review)
    B. Combinations and Permutations
    C. Binomial Coefficients

II.  Probability
    A. Probability Spaces
    B. Independence and Conditional Probability
    C. Combinatorial Probability
    D. Law of Large Numbers

III.  Functions
    A. General Functions
    B. Famous Functions

IV.  Sequences and Series
    A. General Sequences
    B. Series

V.  Logic
    A. Review of Propositional Logic: the converse and contrapositive
    B. Qualifiers
    C. Analysis of Arguments
    D. Classic Proofs

VI.  Compound Interest
    A. What is Compound Interest?
    B. Computing

VII.  General Skills
    A. Estimation and Mental Calculation
    B. Recursive Use of Notation
    C. Broader Context

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Course Coordinator:
Vic Ferdinand
2004-2005

**Mathematics 116**                                **5 cr.**                    **Excursions in Mathematics**
**\*A, W, Sp, Su**

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

## Prerequisite:

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

## Catalog Description:

Critical thinking & 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, 5 ed, Tannenbaum

## Topics List:

**Euler circuits**
    Graphs, Euler's theorem, Fleury's algorithm for an Euler circuit,, Eulerizing graphs
**Traveling Salesman Problem**
    Hamilton circuits and paths, complete graphs, simple strategies for TSP, algorithms for approximate TSP solutions
**Networks**
    Trees, minimum spanning trees, Kruskal's algorithm for finding minimum spanning trees
**Voting**
    Preference ballots, five different methods of determining the winner of an election with 3 or more candidates
**Apportionment**
    Some U.S. history on congressional districts, basic concepts, Hamilton's method, quota rule, Alabama paradox, other methods
**Spiral growth in nature**
    Fibonacci numbers, golden ratio , the equation $x^2 = x + 1$, gnomons, gnomonic growth
**Population growth**
    Its dynamics, exponential growth models, logistic growth models
**Symmetry**
    Geometric symmetry, rigid motions, reflections, rotations, translations, glide reflections, patterns
**Counting**, counting principles, permutations and combinations

Course Coordinator:
Tom Dowling
2004-2005

## Prerequisite:

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

## Catalog Description:

An introduction to differential and integral calculus.

## Purpose of Course:

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

## Follow-up Courses:

There are really no follow-up courses. To start any other mathematics sequence will probably involve beginning at an appropriate entry level course. Students interested in further course work in mathematics should consult the mathematics counselors in 105 Mathematics Bldg.

## Text:

*Calculus: Early Transcendentals*. *Custom Version for Ohio State University*, 10th Edition, Thomas. Published by Addison-Wesley, 2001.

## Calculator:

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

(Over For Topics List And Sample Syllabus)

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## Topics List & Sample Syllabus

| Sections | Topics |
|---|---|
| 0.7 | Modeling Change |
| 1.1 | Rates of Change and Limits |
| 1.5 | Tangent Lines |
| 2.1 | The Derivative as a Function |
| 2.2 | The Derivative as a Rate of Change |
| 2.3 | Derivatives of Products, Quotients, and Negative Powers |
| 2.5 | The Chain Rule |
| 2.4 | Derivatives of Trigonometric Functions |
| 2.8 | Derivatives of Inverse Trigonometric Functions |
| 2.9 | Derivatives of Exponential and Logarithmic Functions |
| 3.1 | Extreme Values of Functions |
| 3.3 | The Shape of a Graph |
| 3.5 | Modeling and Optimization |
| 3.6 | Linearization and Differentials |
| | *Exam I* |
| 4.1 | Indefinite Integrals, Differential Equations, and Modeling |
| 4.3 | Estimating with Finite Sums |
| 4.4 | Riemann sums and Definite Integrals |
| 4.5 | Fundamental Theorem of Calculus |
| 4.2 | Integral Rules: Integration by Substitution |
| 4.6 | Substitution of Definite Integrals |
| 7.5 | Integral Tables |
| 4.7 | Numerical Integration |
| 5.1 | Volumes by Slicing and Rotating about an Axis |
| 5.2 | Modeling Volume by Cylindrical Shells |
| 5.3 | Lengths of Plane Curves |
| (Supplement) | Surface Area |
| 5.5 | Springs, Pumping, and Lifting |
| 5.6 | Fluid Forces |
| 5.7 | Moments and Centers of Mass |
| | *Exam II* |
| | Review and/or Additional Topics in Chapter 11, 12 |

### To be Referred to in Appropriate Sections:

| | |
|---|---|
| 11.1 | Functions of Several Variables |
| 11.3 | Partial Derivatives |
| 11.6 | Linearization and Differentials |
| 11.7 | Extreme Values and Saddle Points |
| 12.1 | Double Integrals |
| 12.2 | Areas, Moments, and Centers of Mass |
| 12.4 | Triple Integrals |
| 12.6 | Masses and Moments in Three Dimensions |

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

Course Coordinator:
Victor Ferdinand
2004-2005

**Mathematics 130**          **4 cr.**          **Math Analysis for Business I**
**A, W, Sp, Su**

## Prerequisite:

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

## Catalog Description:

Equations, inequalities, absolute value, polynomial functions, exponential and logarithmic functions, 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:

Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, Haeussler ,Paul, and Wood, 11th ed.

### Topics & Sample Syllabus

| Sections | Topics |
|---|---|
| 0.7/0.8/1.1 | Applications of Equations, Linear Equations |
| 1.2/1.3 | Applications of Inequalities |
| 2.1/2.2/2.5 | Special Functions, Graphs in Rectangular Coordinates |
| 3.1/3.2 | Lines, Applications, and Linear Functions |
| 3.3/3.4 | Quadratic Functions, System of Linear Equations |
| 3.5/3.6 | Nonlinear Systems, Applications of Systems of Equations |
| 4.1 | Exponential Functions |
| 4.2/4.3 | Logarithmic Functions, Properties of Logarithms |
| 4.4 | Logarithmic and Exponential Equations |
| 5.1/5.2 | Compound Interest, Present Value |
| 5.3 | Annuities |
| 5.4 | Loans and Amortization |

Course Coordinator
Bostwick Wyman
2004-2005

**Math 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, and applications.

## Purpose of Course:
Math 131 is designed to introduce students in the College of Business to differential calculus and related business applications.

## Text:

Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, Haeussler & Paul, 11th ed.

## Topics and Sample Syllabus

| Sections | Topics |
|----------|--------|
| 10.1 | Limits |
| 10.2 | Limits(con't) |
| 10.4 | Continuity |
| 10.5 | Continuity Applied to Inequalities |
| 11.1 | The Derivative |
| 11.2 | Rules for Differentiation |
| 11.3 | The Derivative as a Rate of Change |
| 11.5 | Product and Quotient Rules |
| 11.6 | The Chain Rule and the Power Rule |
| 12.1 | Derivatives of the Logarithmic Functions |
| 12.2 | Derivatives of Exponential Functions |
| 12.4 | Implicit Differentiation |
| 12.5 | Logarithmic Differentiation |
| 12.7 | Higher Order Derivatives |
| 13.1 | Relative Extrema |
| 13.2 | Absolute Extrema on a Closed Interval |
| 13.3 | Concavity |
| 13.4 | Second Derivative Test |
| 13.5 | Asymptotes |
| 13.6 | Applied Maxima and Minima |

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

Course Coordinator
Gloria Woods
2004-2005

**Math 132**         **5 cr.**         **Mathematical Analysis for Business III**

*Note: Wi05 only for Ed. 10*

## 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:

<u>Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences,</u> 10th edition, by Ernest Haeussler/Richard S. Paul, Chapters 15-19.

| Sections | Topics |
|----------|--------|
| 15.2 | Differentials |
| 16.1 | The Indefinite Integral |
| 16.2 | Integration with Initial Conditions |
| 16.3 | More Integration Formulas |
| 16.4 | Techniques of Integration |
| 16.5 | Summation |
| 16.6 | The Definite Integral |
| 16.7 | The Fundamental Theorem of Calculus |
| 16.8 | Area |
| 16.9 | Area Between Curves |
| 16.10 | Consumer Surplus and Producers Surplus |
| 17.3 | Integration by Tables |
| 17.5 | Approximate Integration |
| 17.6 | Differential Equations |
| 17.8 | Improper Integrals |
| 19.1 | Functions of Several Variables |
| 19.2 | Partial Derivatives |
| 19.3 | Applications of Partial Derivatives |
| 19.4 | Implicit Partial Derivatives |
| 19.5 | Higher Order Partial Derivatives |
| 19.7 | Maxima and Minima for Functions of Two Variables |
| 19.8 | Lagrange Multipliers |

Course Coordinator:
Sia Wong
2004-2005

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

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

*Note: Sp 05 begins Edition 11*

## Prerequisite:

Mathematics 131 or 151

## Catalog Description:

Integral Calculus-Indefinite integration, area and definite integrals, improper integrals, functions of several variables, maxima, and minima.

## Purpose of Course:

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

## Text:

Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, 10th edition, by Ernest Haeussler/Richard S. Paul, Chapters 14-15, 17.

| Sections | Topics |
|---|---|
| 14.1 | Differentials |
| 14.2 | The Indefinite Integral |
| 14.3 | Integration with Initial Conditions |
| 14.4 | More Integration Formulas |
| 14.5 | Techniques of Integration |
| 14.6 | Summation |
| 14.7 | The Definite Integral |
| 14.8 | The Fundamental Theorem of Calculus |
| 14.9 | Area |
| 14.10 | Area Between Curves |
| 14.11 | Consumer Surplus and Producers Surplus |
| 15.3 | Integration by Tables |
| 15.4 | Approximate Integration |
| 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 |

| Mathematics 140  Au | 5 cr. | Calculus with Review I |
| Mathematics 141  Wi | 5 cr. | Calculus with Review II |

## Prerequisite:

Level N placement (i.e. placement into Math 148), 4 years of college preparatory math in high school, and some exposure to Calculus. Designed for new first quarter freshmen.

## Catalog Description:

**140:**  Review of polynomial and rational functions, difference quotients, limits, continuity, derivatives, chain rule, higher order derivatives, implicit differentiation, related rates.

**141:**  Trigonometric review, differentiation of the trigonometric functions, review of exponential and logarithmic functions, mean value theorem, applications to curve sketching, applied maxima and minima problems.

## Purpose:

This two quarter sequence is intended for beginning students who (i) aim at a major which requires at least through the 152 level, (ii) placed at level N (and thus would otherwise have to take three math classes to get to Math 152), and (iii) took 4 or more years of college preparatory mathematics in high school. Its purpose is to equip such students to succeed in 152 in the Spring Quarter.

## Follow-up Course:

Students who succeed in both 140 and 141 are prepared for 152. Students failing either course or dropping out of the sequence at any time must meet with the math counselors for rerouting specific to their situation.

## Text:

Calculus (8th edition); Varberg, Purcell, Rigdon. This is the same book as used in 151-152.

## Topics:

The two courses together cover the topics in differential calculus as listed in 151.    The assignments are longer and more searching than is feasible in a standard pace course.    The students, thereby reinforce their mastery of algebra, analytic geometry, and trigonometry.

Course Coordinator:
TBA
2004-2005

| Mathematics 148 | 4 cr. | Algebra and Trigonometry |
| A, W, 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 (resp. logarithmic) equations.

## Purpose of Course:

To help students make the transition from abstract mathematics to concrete applications, 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 OSU Custom Edition (2004 – 2005), Hungerford

**Technology:** All students are required to have a graphing calculator.

## 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 |
| 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 & Arclength and Area of a Circular Sector |
| 6.3 | Geometry: Similar Triangles |
| 9.1 | Trigonometric Functions of Acute Angles |
| 9.2 | Applications of Right Triangle Trigonometry |
| 9.3 | The Law of Cosines |
| 9.4 | The Law of Sines |

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

Course Coordinator:
David George
2004 - 2005

**Mathematics 150**        **5 cr.**        **Elementary Functions**
**A, W, Sp, Su**

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

## Catalog Description:
Inverse functions, logarithmic, exponential and trigonometric functions, and their graphs; complex numbers.

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

## Follow-up Course:
Math 151 or Math 117

## Text:
Algebra and Trigonometry-Enhanced with Graphing Utilities, Sullivan and Sullivan, 3rd ed.

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

| Sections | Topics |
|---|---|
| 2.1 | Functions |
| 3.1 | Symmetry: Graphing Key Equations |
| 3.2 | Properties of Functions |
| 3.3 | Library of Functions: Piecewise-Defined Functions |
| 3.4 | Graphing Techniques: Transformations |
| 4.1 | Power Functions and Models |
| 4.2 | Polynomial Functions and Models |
| 4.3 | Rational Functions I |
| 4.4 | Rational Functions II: Analyzing Graphs |
| 4.5 | Polynomial and Rational Inequalities |
| 6.1 | One-to-One Functions: Inverse Functions |
| 6.2 | Exponential Functions |
| 6.3 | Logarithmic Functions |
| 6.4 | Properties of Logarithms |
| 6.5 | Logarithmic and Exponential Functions |
| 8.1 | Angles and Their Measure |
| 8.2 | Right Triangle Trigonometry |
| 8.3 | Computing the Values of Trigonometric Functions of Given Angles |
| 8.4 | Trigonometric Functions of General Angles |
| 8.5 | Properties of the Trigonometric Functions: Unit Circle Approach |
| 8.6 | Graphs of the Sine and Cosine Functions |
| 8.7 | Graphs of the Tangent, Cotangent, Cosecant, and Secant Functions |
| 8.8 | Phase Shift: Sinusoidal Curve Fitting |
| 9.1 | The Inverse Sine, Cosine, and Tangent Functions |
| 9.2 | Inverse Trigonometric Functions (continued) |
| 9.3 | Trigonometric Identities |
| 9.4 | Sum and Difference Formulas |
| 9.5 | Double-Angle and Half-Angle Formulas |
| 9.7 | Trigonometric Equations I |
| 9.8 | Trigonometric Equations II |
| 11.1 | Polar Coordinates |
| 11.2 | Polar Equations and Graphs |
| 11.3 | Complex Plane: De Moivre's Theorem |

Course Coordinator:
Paul Ponomarev
2004-2005

**Mathematics 151**          5 cr.          **Calculus and Analytic Geometry**
**A, W, Sp, Su**

### Prerequisite:

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

### Catalog Description:

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

### Purpose of Course:

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

### Follow-up Course:

Math 152

### Text:

*Calculus,* Dale Varberg, Edwin J. Purcell, and Steven E. Rigdon, 8$^{th}$ edition, customized for OSU (some text as 03-04 with Just In Time added).

### Topics & Sample Syllabus:

| Sections | Topics |
| --- | --- |
| 2.1 | Functions and Their Graphs |
| 2.2 | Operations on Functions |
| 2.3 | Trigonometric Functions |
| 2.4 | Introduction to Limits |
| 2.6 | Limit theorems involving trig functions |
| 2.7 | Limits |
| 2.8 | Limits at infinity |
| 2.9 | Continuity of Functions |
| 3.1 | Slope of a tangent line and instantaneous velocity |
| 3.2 | The Derivative |
| 3.3 | Rules for finding Derivatives |
| 3.4 | Derivatives of Trigonometric Functions |
| 3.5 | The Chain Rule |
| 3.6 | Leibniz Notation |
| 3.7 | Higher-Order Derivatives |
| 3.8 | Implicit Differentiation |
| 3.9 | Related Rates |
| 3.10 | Differentials and Approximations |
| 4.1 | Maxima and Minima |
| 4.2 | Monotonicity and concavity |
| 4.3 | Local Maxima and Minima |
| 4.4 | More max-min problems |
| 4.6 | Sophisticated Graphing |
| 4.7 | The Mean-Value Theorem |
| 5.1 | Antiderivatives |

Course Coordinator:
Thomas Kerler
2004-2005

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

**Mathematics 152**
**Wi, Sp, Su**

5 cr.

**Calculus and Analytic Geometry**

**Prerequisite:**

Mathematics 151

**Catalog Description:**

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

**Purpose of Course:**

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

**Follow-up Course:**

Math 153

**Text:**

*Calculus, Dale Varberg, Edwin J. Purcell, and Steven Rigdon, 8th edition, customized for OSU.

(Over for Topics List & Sample Syllabus)

## Topics List & Sample Syllabus

Course Coordinator:
Zbigniew Fiedorowicz
2004-2005

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

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

## Prerequisite:
Mathematics 152

## 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.

## Follow-up Course:
Math 254

## Text:
*Calculus by Varberg, Purcell, and Rigdon, 8th edition, customized for OSU.

### Topics & Sample Syllabus

| Sections | Topics |
|---|---|
| | INFINITE SERIES: |
| 10.1 | Infinite Sequences |
| 10.2 | Infinite Series |
| 10.3 | Positive Series: The Integral Test |
| 10.4 | Positive Series: Other Tests |
| 10.5 | Alternating Series, Absolute Convergence, Conditional Convergence |
| 10.6 | Power Series |
| 10.7 | Operations on Power Series |
| 10.8 | Taylor and Maclaurin Series |
| | CONICS AND POLAR COORDINATES: |
| 12.1 | The Parabola |
| 12.2 | Ellipses and Hyperbolas |
| 12.3 | More on Ellipses and Hyperbolas |
| 12.4 | Translation of Axes |
| 12.5 | Rotation of Axes |
| 12.6 | The Polar Coordinate System |
| 12.7 | Graphs of Polar Equations |
| 12.8 | Calculus in Polar Coordinates |
| | GEOMETRY IN THE PLANE, VECTORS |
| 13.1 | Plane Curves: Parametric Representation |
| 13.2 | Vectors in the Plane: Geometric Approach |
| 13.3 | Vectors in the Plane: Algebraic Approach |
| 13.4 | Vector-Valued Functions and Curvilinear Motion |
| 13.5 | Curvature and Acceleration |
| | GEOMETRY IN SPACE, VECTORS |
| 14.1 | Cartesian Coordinates in Three-Space |
| 14.2 | Vectors in Three-Space |
| 14.3 | The Cross Product |
| 14.4 | Lines and Curves in Three-Space |
| 14.5 | Velocity, Acceleration, and Curvature |
| 14.6 | Surfaces in Three-Space |
| 14.7 | Cylindrical and Spherical Coordinates |

Mathematics 151A  Au            5 cr. each        **Calculus and Analytic Geometry**
Mathematics 152A  Wi
Mathematics 153A  Sp
Mathematics 254A  Au

## Prerequisite:

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

## Catalog Description:

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

## Purpose of Course:

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

## Follow-up Course:

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

## Text:

Calculus, Single and Multivariable, Hughes-Hallett, Gleason, et al., 3$^{rd}$ ed.

## Topics:

**151A:** Chapters 1, 2, 3, and 4. Topics include rational, exponential, logarithmic, and trigonometric functions, and the concept, computation and applications of derivatives, L'Hopital's Rule.

**152A:** Chapters 5, 6, 7, and 8. Topics include antiderivatives, computation of indefinite and definite integrals, and the concept and applications of integration.

**153A:** Chapters 9, 10, 12, 13, sections 3.8 and 17.1-17.2, Appendices B and C, cylindrical and spherical coordinates (and 17.3-17.4 if time permits). Topics include approximations and series, functions of several variables, vectors, polar coordinates, and complex numbers.

**254A:** Chapters 14, 16, (17.3-17.4 if not covered in 153A) 18, 19, and 20. Topics include differentiation and integration of functions of several variables; vector fields; line integrals; and calculus of vector fields.

Course Coordinator:
Angela Barnhill
2004-2005

| | | | |
|---|---|---|---|
| Mathematics 151C | Au, Wi | 5 cr. each | Calculus and Analytic Geometry |
| Mathematics 152C | Wi, Sp | | |
| Mathematics 153C | Sp, Au | | |
| Mathematics 254C | Au, Wi | | |

## Prerequisite:

The prerequisites are the same as those for 151, 152, 153, 254. e.g. for 151C the prerequisite is Math 150 or satisfactory score on the mathematics placement test.

## Catalog Description:

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

## Purpose of Course:

This sequence, Calculus & Mathematica, covers the material of Math 151,152,153, and 254 in a tutorial fashion, using an electronic "living" textbook on MacIntosh computers. The powerful graphing and symbolic manipulation available on microcomputers allows for upgrading the standard calculus courses to provide deeper insights than were previously possible. There are no lectures, only extensive tutorial sessions. Students work in the math lab with supervision and help from faculty and graduate teaching assistants. There is also a weekly discussion session. Math 151C is open to Course Code L freshmen who have the attitude and interest to commit themselves to the course.

## Follow-up Course:

After finishing 254C, students will be ready to move on to courses in differential equations or linear algebra. Additional Mathematics courses - 255C, 415C, 568Cand 513C - are now offered occasionally.

## Text:

Calculus & Mathematica, Davis, Porta & Uhl, Addison-Wesley, 1994.

For 151C: Calculus & Mathematica: Derivatives
For 152C: Calculus & Mathematica: Integrals
For 153C: Calculus & Mathematica: Approximations
For 254C: Calculus & Mathematica: Vector Calculus

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

Course Coordinator:
Nela Lakos
2004-2005

| Mathematics 161  Au | 5 cr. each | Accelerated Calculus |
|---|---|---|
| Mathematics 162  Wi | | with Analytic Geometry |
| Mathematics 263  Sp | | |

## Prerequisite:

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

## Catalog Descriptions:

**161:**  Derivatives and their applications, integrals and their applications, for real-valued functions of one variable.

**162:**  Infinite sequences and series, polynomial approximation of functions and Taylor series expansion of functions; vector algebra and geometry with application to space curves and lines and planes in 3-space.

**263:**  Partial derivatives and their applications, multiple integrals and their applications, for real-valued functions of several variables; line and surface integrals.

## Purpose of Course:

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

## Follow-up Course:

Courses in differential equations or linear algebra, possibly H520.

## Text:

Calulus  (8th edition customized for OSU); Varberg, Purcell, Rigdon.

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

## Topics:

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

**162** - Sequences and series, power series, Taylor's theorem, convergence tests, vectors, dot and cross product.

**263** - Surfaces, cylindrical and spherical coordinates, partial derivatives, multiple integrals, line integrals, vector fields, Green's and Stoke's Theorems.

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

Course Coordinator:
Henry Glover
2004-2005

| Math 161 A | Au | 5 cr. | **Accelerated Calculus with** |
| Math 162 A | Wi | | **Analytic Geometry I, II, III** |
| Math 263 A | Sp | | |

## Prerequisite:

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

## Catalog Description:

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

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

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

## 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. In 1993-94, the calculus was included with engineering mechanics in the classes ENG 194A, 194B, 194C. In 1994-95 they were offered as Math 194D, 194F, 194G. For 95-96 and 96-97 the third quarter was 294G. They were officially renamed 161A, 162A, 263A in 04-05,

## Text:

Calculus, (8<sup>th</sup> ed.), D. Varberg, E. J. Purcell and S.E. Rigdon.

## Topics:

Generally, the first quarter does the equivalent of 151 and 152. Generally, the second quarter covers153; and the third quarter covers 254, and some additional topics.

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

Course Coordinator:
Nela Lakos
2004-2005

| Mathematics H161 Au | 5 cr. | Accelerated Calculus |
| Mathematics H162 Wi | | with Analytic Geometry |
| Mathematics H263 Sp | | |

## Prerequisite:

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

## Catalog Description:

The catalog descriptions for H161, H162, and H163 are the same as those for 161,162, and 263 (respectively)-see listing for those courses.

*HOWEVER-these descriptions as currently listed in the University Bulletin are <u>not correct</u>; for a more accurate description of their content, see "Topics" section below.*

## Purpose of Course:

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

## Follow-up Course:

After completing H263, students will be ready for Math H520 (or any other course in differential equations or linear algebra).

## Text:

<u>Calculus with Analytic Geometry</u>, 2nd edition, Simmons

*NOTE: The textbooks for the Math 161 sequence and Math 151 sequence are not the same as H161.*

## Topics:

**H161** will assume mastery of the computational aspects of polynomial and trigonometric differentiation, will briefly review the Mean Value Theorem, and will concentrate on integral calculus of the polynomial, logarithmic, exponential, trigonometric and inverse trigonometric functions, integration techniques, and applications.

**H162**-Sequences and series, power series, Taylor's theorem, convergence tests, vectors, dot and cross product, arc length, space curves.

**H263**-Vectors, parametric equations, surfaces, cylindrical and spherical coordinates, partial derivatives, multiple integrals, line integrals, vector fields, Green's theorem, Divergence theorem, Stokes' theorem.

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

Course Coordinator:
V. Bergelson
2004-2005

**Mathematics H487**　　　　　　**2 cr.**　　　　　**Advanced Problem Solving**
**Mathematics H187**
**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. 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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Course Coordinator:
V. Bergelson
2004-2005

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

## Prerequisite:

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

## Catalog Descriptions:

**H190:**   Special course for superior students.

**H191:**   Continuation of H190.

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

## Purpose of Course:

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

## Follow-up Sequence:

Math H520, H521, H522

## Texts vary, for example:

Calculus, Spivak, 3rd. ed -for H190, H191.
Vector Calculus, 4th edition, Marsden/Tromba- for H264 (used in Spring '00 and Spring '03)
Advanced Calculus of Several Variables, Edwards, Jr. – for H264 (used in Spring '01)
Advanced Calculus, 3rd edition, Buck - for H264 (used in Spring '02)

## Topics:

**H190 - H191:**   Properties of real numbers.   Mathematical induction.   Definition of integral. Integrals of polynomials and trigonometric functions.   Applications.   Continuity, limits, derivatives and applications.   Fundamental Theorem of Calculus and integration techniques.   Taylor series. Sequences and series of numbers and functions.   Uniform convergence.   Power series.   If time permits, some differential equations or complex-valued functions.

**H264:**   Multivariable calculus (vector approach), gradients, multiple integrals, line and surface integrals, Green's Theorem, divergence theorem, Stokes' Theorem.

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Course Coordinator:
V. Bergelson
2004-2005

**Mathematics 254**  **5 cr.**  **Calculus and Analytic Geometry**
**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 by Varberg, Purcell, and Rigdon, 8th edition, customized for OSU.

## Topics & Sample Syllabus

| Sections | Topics |
|---|---|
| | THE DERIVATIVE IN $n$-SPACE |
| 14.7 | Cylindrical and Spherical Coordinates |
| 15.1 | Functions of Two or More Variables |
| 15.2 | Partial Derivatives |
| 15.3 | Limits and Continuity |
| 15.4 | Differentiability |
| 15.5 | Directional Derivatives and Gradients |
| 15.6 | The Chain Rule |
| 15.7 | Tangent Planes, Approximations |
| 15.8 | Maxima and Minima |
| 15.9 | LaGrange's Method |
| | THE INTEGRAL IN $n$-SPACE |
| 16.1 | Double Integrals over Rectangles |
| 16.2 | Iterated Integrals |
| 16.3 | Double Integrals over Nonrectangular Regions |
| 16.4 | Double Integrals in Polar Coordinates |
| 16.5 | Applications of Double Integrals |
| 16.6 | Surface Area |
| 16.7 | Triple Integrals (Cartesian and Coordinates) |
| 16.8 | Triple Integrals (Cylindrical and Spherical Coordinates) |
| | VECTOR CALCULUS |
| 17.1 | Vector Fields |
| 17.2 | Line Integrals |
| 17.3 | Independence of Path |
| 17.4 | Green's Theorem in the Plane |
| 17.5 | Surface Integrals |
| 17.6 | Gauss's Divergence Theorem |
| 17.7 | Stoke's Theorem |

Course Coordinator:
TBA
2004-2005

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| Mathematics 255 | Au, Wi, Sp, Su | 5 cr. | Differential Equations |
| Mathematics 255C | Au, Wi, Sp | | 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 edition, red cover, custom version), Boyce and DiPrima. (Math 255).

Differential Equations & Mathematica, Davis (255C).

## Topics & Sample Syllabus

| Sections | Topics | Approximate Time |
|---|---|---|
| | **Introduction** | |
| 1.1 | Some Basic Mathematical Models; Direction Fields | 2 lectures |
| 1.2 | Solutions of Some Differential Equations | |
| 1.3 | Classification of Differential Equations | |
| 2.2 | Separable Equations | |
| | | |
| | **First Order Differential Equations** | |
| 2.1 | Linear Equations with Variable Coefficients | 6 lectures |
| 2.4 | Differences Between Linear and Nonlinear Equations | |
| 2.5 | Autonomous Equations and Population Dynamics | |
| 2.6 | Exact Equations and Integrating Factors | |
| 2.7 | Numerical Approximations: Euler's Method | |
| 2.8 | The Existence and Uniqueness Theorem | |
| | | |
| | **Second Order Linear Equations** | |
| 3.1 | Homogeneous Equations with Constant Coefficients | 5 lectures |
| 3.2 | Fundamental Solutions of Linear Homogeneous Equations | |
| 3.3 | Linear Independence and the Wronskian | |
| 3.4 | Complex Roots of the Characteristic Equation | |
| 3.5 | Repeated Roots; Reduction of Order | |
| 3.6 | Nonhomogeneous Equations; Method of Undetermined Coefficients | |
| 3.7 | Variation of Parameters | |

*MIDTERM #1*

(Topics Cont'd)

## Topics & Sample Syllabus, cont'd

**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 | |

**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, transfinite 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 which 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) and algebra (580). Students may also find Math 345 helpful as preparation for probability (530), topology (560), linear algebra (568 or 571), number theory (573), geometry (574) and combinatorial mathematics and graph theory (575).


## Text:

The Fundamentals of Higher Mathematics, Falkner

Other useful references:

Theory and Problems of Set Theory and Related Topics (Schaum's Outline), Lipschutz.
How to Read and Do Proofs, Solow.
The Foundations of Mathematics, Stewart and Tall.

Course Coordinator:
Neil Falkner
2004-2005

| Mathematics 366 | 3 cr. | Discrete Mathematical |
| A, W, Sp, Su (1st Term) | | Structures I |

## Prerequisite:

Mathematics 132 or 152.

## Catalog Description:

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

## Purpose of Course:

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

## Follow-up Course:

Math 566.

## Text:

Discrete Mathematics with Applications, S. S. Epp, 3rd edition

(Over for Topics List)

## 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 | Predicates and Quantified Statements I |
| 2.2 | Predicates and Quantified Statements II |
| 2.3 | 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 |
| 3.6 | Indirect Argument: Contradicton 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 | The Empty Set, Partitions, Power Sets, and Boolean Algebras |
| | RELATIONS |
| 10.1 | Relations on Sets |
| | FUNCTIONS |
| 7.1 | Functions Defined on General Sets |
| 7.3 | One-to-One and Onto, Inverse Functions |
| 7.5 | Composition of Functions |

Course Coordinator:
Timothy Carlson
2004-2005

**Mathematics 414**              .3 cr.        **Group Studies: Differential Equations**
**SP**                                                                **for Engineering Applications**

*(Prior to Spring 2001, this course was offered as 694D.)*

**Prerequisite:**

To be taken concurrently with Aero-Eng 414 or permission from instructor.

**Catalog Description:** .

Introduction to the basic methods for solving ordinary and partial differential equations, and some applications.

**Purpose of Course:**

This course is intended to introduce students to the basic methods for solving ordinary and partial differential equations, and to present some applications. This course will be coordinated with the course Aero-Eng 414, taught by the Dept. of Aerospace Engineering, Applied Mechanics, and Aviation, where students will be introduced to the physical concepts of conduction heat transfer and vibrations with applications primarily in aerospace engineering. Our goal is that the student will have a greater appreciation of the mathematical techniques being taught as well as developing skills to solve specific heat conduction and vibration problems that arise in engineering applications.

**Texts:**

Elementary Differential Equations and Boundary Value Problems, 7th edition, Boyce and DiPrima.

(Over for Topics List & Sample Syllabus)

## Topics List & Sample Syllabus:

| Sections | Topics |
| --- | --- |
| 1.1, 2.5, 2.7 | Introduction to Differential Equations and some Applications: Cooling, Compound Interest, Mixing, and/or Mechanics. |
| 2.1, 2.2 | Linear First Order ODE's and Integrating Factors |
| 2.5 | Applications from Lecture 1 revisited |
| 2.7, 2.3 | Applications: Mechanics: Separable Equations |
| 2.3, 2.4, 2.2 | Differences Between Linear and Nonlinear Equations, Bernoulli's Equation |
| 2.8 | Exact equations |
| 2.6 | Qualitative Properties of solutions--Equilibrium solutions, Stability, sketch of solutions, apply to chemical kinetics |
| 3.8, 3.1 | Vibrations , Define Linear Homogeneous and Inhomogeneous Equations, Principle of Superposition of Solutions for Homogeneous Linear Equations, Constant Coefficient Equations with Distinct Roots of the Characteristic Polynomial |
| 3.2, 3.3 | Fundamental Solutions, Linear Independence, Wronskian |
| 3.4, 3.5 | Review Properties of Complex Numbers (Handout), Complex Roots, and Repeated Roots of the Characteristic Equation |
| 5.5 | Euler's Equation |
| 3.6 | Nonhomogeneous Equations: Method of Undetermined Coefficients |
| 3.7 | Nonhomogeneous Equations: Variation of Parameters |
| 5.1 | Review of Power Series |
| 5.2 | Examples of Series Solutions near an Ordinary Point |
| 5.4, 5.6-5.8 | Regular Singular Points, Frobenius Method, Bessel's Equation |
| 10.2-10.4 | Fourier Series, Convergence of Fourier Series, Even and Odd Functions |
| 10.6 | The Wave Equation--Derivation, Solution and Applications |
| 6.1-6.3,6.6 | Laplace Transform, Solution of Ordinary Differential Equations, Shifting Theorems, Convolution |

**Mathematics 415    Au, Wi, Sp, Su**
**Mathematics 415C  Au, Wi, Sp**

        **4 cr.**

**Ordinary and Partial**
**Differential Equations**

## Prerequisite:

Mathematics 254

## Catalog Description:

Ordinary, partial, linear and non-linear differential equations. Fourier series, boundary value problems and Bessel functions.

## Purpose of Course:

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

## Text:

Elementary Differential Equations and Boundary Value Problems, 7th edition, Boyce and DiPrima. (415)

Differential Equations & Mathematica, Davis (415C)

(Over for Topics List)

## Topics:

| | |
|---|---|
| 1.1-1.3 | Introduction to differential equations, including some applications for motivation |
| 2.1 | Linear first order ordinary differential equations (ODEs) and integrating factors |
| 2.2 | Separable equations |
| 2.3 | Applications of linear equations |
| 2.4 | Bernoulli's equation: Differences between linear and nonlinear equations |
| 2.5 | Qualitative theory for solving nonlinear ODEs |
| 2.6 | Exact equations |
| 3.1 | Homogeneous equations with constant coefficients |
| 3.2, 3.3 | Fundamental solutions, linear independence, Wronskian |
| 3.4 | Complex numbers and complex roots of the characteristic polynomial |
| 3.5 | Repeated real roots of the characteristic equation and the method of reduction order |
| 3.6 | Nonhomogeneous equations: method of undetermined coefficients |
| 3.7 | Nonhomogeneous equations: method of variation of parameters |
| 3.8, 3.9 | Vibrations with and without damping and forcing |
| 5.1 | Review of power series |
| 5.2 | Examples of series solutions near regular points |
| 10.1 | Two-point boundary value problems |
| 10.2, 10.3 | Fourier series, 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'Llembert's solution |
| 10.8 | Laplace's equation |

Course Coordinator:
Fangyang Zheng
2004-2005

**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.

## Texts:

Texts used in the past include:

A History of Mathematics, Carl B. Boyer and Ute Merzbach
Mathematics and its History, Stillwell
A History of Mathematics - An Introduction, Victor J. Katz (2$^{nd}$ ed.)
Fermat's Enigma, S. Singh

## Topics:

The topics will vary based on the instructors.

Course Coordinator:
Bostwick Wyman
2004-2005

**Mathematics 507**
**A, W**

                              5 cr.                    **Advanced Geometry**

## Prerequisite:

Mathematics 345 or GRAD standing

## Catalog Description:

Advanced topics from Euclidean Geometry.

## Purpose of Course:

To expand on the standard high school geometry curriculum, introducing related topics such as spherical and hyperbolic geometry to clarify and illustrate the special role played by Euclidean geometry.

## Text:

Math 507 course packet

## Optional Reference:

Clemens & Clemens, Geometry for the Classroom, Springer Verlag.

Greenberg, Euclidean & Non-Euclidean Geometries, W.H. Freeman & Co.

## Topics:

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

Course Coordinator:
Herb Clemens
2004-2005

| Mathematics 512 | 3 cr. | Partial Differential Equations |
| A, W, 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 and Boundary Value Problems with Fournier Series, 2$^{nd}$ Edition, Asmar.

### Topics List & Sample Syllabus

| Sections | Topics | Approximate Time |
|---|---|---|
| 1.1-1.2 | Introduction | 10 days* |
| 2.1-2.4, 2.6-2.7 | Fournier Series | |
| 2.6 | Complex Form of Fournier 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 | Laplacian Transforms | |
| 8.2 | Application of Laplace Transform to PDE's (or other applications | |

*Including a test

**Only rectangular coordinates are required.

Course Coordinator:
Bong-Sik Kim
2004-2005

| 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 "skills" 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, Davis and Snider, 7th edition

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

## Topics & Sample Syllabus

| Sections | Topics | Approximate Time |
|---|---|---|
| 1.1-1.12, 1.14 | Review vector algebra, geometry, Dot and cross products, lines and planes | 4 days |
| 2.1-2.3 (2.4 optional) | Vector functions of one variable, arc length, Velocity, acceleration, curvature | 5 days |
| 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, Stoke's Theorem, potentials, Applications | 13 days |

## 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. It does not include any applied science applications from fluid mechanics or electricity and magnetism, for example.

*(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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Course Coordinator:
Ulrich Gerlach
2004-2005

**Mathematics 514**            **3 cr.**            **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, Churchill, 5th edition (used Sp 93, Sp 94, Sp 95)

**Possible Alternative Text:**
Advanced Engineering Math, Kreyszig, 8th edition

Kreyszig contains much diverse material. It is an excellent reference for engineers on many topics in mathematics.

Each text has too much material, so it is helpful to give a review sheet before tests. Use the text for reference and use the lectures to make the text understandable.

**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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Course Coordinator:
Fei-Ran Tian
2004-2005

**Mathematics H487**     **2 cr.**     **Advanced Problem Solving**
**Mathematics H187**
**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. 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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Course Coordinator:
V. Bergelson
2004-2005

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

## Prerequisites:

H520-H263 or H264 with a grade of C or better, or written permission
     of Honors Committee chairperson.

H521-H520 with a grade of C or better or written permission of Honors Committee chairperson.

H522-H521 with a grade of C or better or written permission of Honors Committee chairperson.

## Catalog Descriptions:

**H520:** Vector spaces, linear transformations, systems of equations, determinants, eigenvalues,
     spectral theorem, Cayley-Hamilton theorem.

**H521:** Ordinary, linear and nonlinear differential equations, existence and uniqueness theorems,
     Fourier series, boundary value problems, systems, Laplace transforms, phase space,
     stability and periodic orbits.

**H522:** Analytic functions, Cauchy integral theory, residue calculus, series representations,
     conformal mapping.

## Purpose of Course:
This three quarter sequence is the second year of the honors program in mathematics. It is
designed to challenge talented, highly motivated students, regardless of their chosen major. This
sequence substitutes for Math 568 and 569, Math 255 or 415, and Math 514 or 552; the level of
rigor is higher than in any of these classes. It is taught by faculty members in small sections with
considerable teacher-student interaction.

**Texts** vary, for example:

**Autumn: H520**
Valenza, Linear Algebra: An Introduction to Abstract Mathematics (1998)
Dettman, Introduction to Linear Algebra and Differential Equations (1999)
Strang, Linear Algebra and Its Applications (2000)
Axler, Linear Algebra Done Right (2001)
Curtis, Linear Algebra: An Introductory Approach (used in 2003, 2004)

**Winter: H521**
Dettman, Introduction to Linear Algebra and Differential Equations (2000)
Strogatz, Nonlinear Dynamics and Chaos (2001)
Coddington, An Introduction to Ordinary Differential Equations (1999, 2002, 2003)
Simmons, Differential equations with Applications & Historical Notes, 2$^{nd}$ Edition (2005)

**Spring: H522**
Flanigan, Complex Variables: Harmonic and Analytic Functions (used in Spring '99)
Bak-Newman, Complex Analysis, 2$^{nd}$ edition (used in Spring '01)
Silverman, Complex Analysis with Applications, (used in Spring 2003)

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

Course Coordinator:
V. Bergelson
2004-2005

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

**Prerequisite:**

Mathematics 254.

**Catalog Description:**

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

**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, Jim Pitman.

**Topics:**

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

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

## Prerequisite:

Mathematics 530 or Statistics 520, or permission of instructor.

## Catalog Description:

Problem Workshop for applications of calculus and probability to 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 Review manual for Exam P.

Course Coordinator:
Bostwick Wyman
2004-2005

**Mathematics H540**　　　　　　**5 cr.**　　　**Geometry and Calculus in Euclidean**
**Wi\***　　　　　　　　　　　　　　　　　　**Spaces and on Manifolds I**

**\* Offered in odd years only (Wi 2003, Wi 2005, etc.)**

## Prerequisite

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

## Catalog Description

The topology of $E^n$ , differentiation of vector valued functions, inverse and implicit function theorems, Riemann and Lesbegue integration in $E^n$ .

## Purpose of Course

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

## Follow-up course

Math H541.

## Texts vary, for example:

Differential Geometry of Curves and Surfaces, DoCarmo, (used Winter 2003)
Elements of Differential Geometry, R. Milman and G. Rarker
Elementary Topics in Differential Geometry, Thorpe (used Winter 2005)

## Topics

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

**Mathematics H541**  **5 cr.**  **Geometry and Calculus in Euclidean**
**Sp***  **Spaces and on Manifolds II**

**\* Offered in odd years only (Sp 2003, Sp 2005, etc.)**

## Prerequisite

Mathematics H540, or permission of the instructor

## Catalog Description

Curves and line integrals in $E^n$ , tensor and exterior algebras, differential forms, integration on manifolds, divergence and Stokes' theorem and applications.

## Purpose of Course

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

## Texts vary, for example:

Differential Geometry of Curves and Surfaces, DoCarmo, (used Winter 2003)
Elements of Differential Geometry, R. Milman and G. Rarker
Elementary Topics in Differential Geometry, Thorpe (used Winter 2005)

## Topics

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

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Course Coordinator:
V. Bergelson
2004-2005

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 ed., Bartle/Sherbert

## Topics:

1. Monotone functions. Monotone sequences.

2. Boundedness. Estimations.

3. Definition of the limit of a sequence. Limit rules. Standard examples.

4. Principle of nested intervals. The Bolzano-Weierstrass Theorem. The Cauchy Criterion. Supremum and infimum.

5. Infinite series. Comparison tests. Ratio and root tests. Integral test. Absolute convergence.

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

Course Coordinator:
Paul Nevai
2004-2005

| 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 or 551 or 552.

**Text:**

Introduction to Real Analysis, 3rd ed., Bartle/Sherbert

**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.

DEPARTMENT OF MATHEMATICS
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Course Coordinator:
Paul Nevai
2004-2005

**Mathematics 549**
**Au,Sp**

**3 cr.**

**Introductory Analysis III**

## 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 ed., Bartle/Sherbert

## 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.

**DEPARTMENT OF MATHEMATICS**
**THE OHIO STATE UNIVERSITY**
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**COLUMBUS, OHIO 43210-1174**

Course Coordinator:
Paul Nevai
2004-2003

**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, Thomas H. Barr

Other References:
Advanced Calculus, 2nd ed., Wilfred Kaplan. (With supporting problems from Schaum's.)
Vector Calculus, 3rd Edition, T.E. Marsden and A. J. Tromba. (used 90-91)

**Topics:**

Review of vectors (dot product, cross product), curves, gradient, curl, divergence, line integrals, surface integrals, the Divergence Theorem, Green's Theorem, Stoke's 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 Stoke's theorem.

| Sections | Topics | Approximate Time |
|---|---|---|
| 1.1-1.7 (1.2-1.3 optional) | Review of vectors (dot product and cross product), lines and planes | 2 weeks |
| 1.8-1.9 | Vector valued functions, derivatives | |
| 3.7 | Gradient | 2 weeks |
| 3.8 | Divergence and curl | |
| 4.1, 4.2, 4.5, 4.6 | Arc length, line integrals, surface area, integrals | 6 weeks |
| 5.1-5.4 | Conservative vector fields, Green's Theorem, Divergence Theorem, Stoke's Theorem | |

Section 4.6 introduces notation of differential forms but it doesn't really go into the topic of differential forms. Other possible topics that could be included are the topics of Curvilinear coordinates: curl and divergence in spherical and cylindrical coordinates (for example, from the book Vector Analysis, Davis/Snyder, Section 3.10).

**Mathematics 552**      **5 cr.**      **Introduction to the Theory of**
**Su**                                  **Functions of a Complex Variable**

## Prerequisite:

Mathematics 254

## Catalog Description:

Topics discussed include power series expansions, the formula of Cauchy, residues, conformal mappings, and elementary functions in the complex domain.

## Purpose of Course:

The students are to learn the basic facts and techniques of complex variables, as done in, for instance, the first eight or more chapters of Churchill and Brown. The fact that it is a 5 hour course permits more depth than is possible in 514. Because the course has minimal prerequisites, the emphasis will be on problem solving techniques. This course is not open to students with credit for 514.

## Text:

Complex Variables and Applications, Churchill and Brown , Seventh Edition.

## Topics:

Algebra of complex numbers, geometry of the complex plane, elementary functions, conformal mappings, Taylor's and Laurent's series, residue calculus.

**Mathematics 566**
**A, W, Sp, Su (2nd Term)**

**3 cr.**

**Discrete Mathematical**
**Structures II**

## 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, networks.

## Purpose of Course:

Follow-up to Math 366. The desire of the CSE 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, S. S. Epp, 3rd edition.

### Topics and Sample Syllabus

| Sections | Topics |
|----------|--------|
|          | COUNTING |
| 6.1      | Counting and Probability |
| 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 |
| 6.5      | R-Combinations with Repetition Allowed |
| 6.7      | The Binomial Theorem |
|          | RECURSION |
| 8.1      | Recursively Defined Sequences |
| 8.2      | Solving Recurrence Relations by Iteration |
| 8.3      | Second-Order Homogeneous Recurrence Relations with Constant Coefficients |
| 8.4      | General Recursive Definitions |
|          | O-NOTATION AND THE EFFICIENCY OF ALGORITHMS |
| 9.1      | Real-Valued Functions of a Real Variable and Their Graphs |
| 9.2      | O-Notation |
|          | 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 |

DEPARTMENT OF MATHEMATICS
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231 WEST EIGHTEENTH AVENUE

Course Coordinator:
Timothy Carlson
2004-2005

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

## Prerequisite:
Mathematics 254. Not open to students with credit for 571.

## Catalog Description:
The space $R^n$ and its subspaces; matrices as mappings; matrix algebra; systems of equations; determinants; dot product in $R^n$; 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, is 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 and its Applications, Lay, Addison-Wesley, 3rd edition.

### Topics and Sample Syllabus

| Sections | Topics |
|---|---|
| **LINEAR EQUATIONS IN LINEAR ALGEBRA** | |
| 1.1 | Systems of Linear Equations |
| 1.2 | Row Reduction and Echelon Forms |
| 1.3 | Vector Equations |
| 1.4 | The Matrix Equation |
| 1.5 | Solution Sets of Linear Systems |
| 1.7 | Linear Independence |
| 1.8 | Introduction to Linear Transformations |
| 1.9 | The Matrix of a Linear Transformation |
| **MATRIX ALGEBRA** | |
| 2.1 | Matrix Operations |
| 2.2 | The Inverse of a Matrix |
| 2.3 | Characterizations of Invertible Matrices |
| 2.8 | Subspaces of $R^n$ |
| 2.9 | Dimension and Rank |
| **DETERMINANTS** | |
| 3.1 | Introduction to Determinants |
| 3.2 | Properties of Determinants |
| 3.3 | Cramer's Rule, Volume, and Linear Transformations |
| **EIGENVALUES AND EIGENVECTORS** | |
| 5.1 | Eigenvectors and Eigenvalues |
| 5.2 | The Characteristic Equation |
| 5.3 | Diagonalization |
| **ORTHOGONALITY AND LEAST SQUARES** | |
| 6.1 | Inner Product, Length, and Orthogonality |
| 6.2 | Orthogonal Sets |
| 6.3 | Orthogonal Projections |
| 6.4 | The Gram-Schmidt Process |

Course Coordinator:
Harry Allen
2004-2005

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

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

## Prerequisite:

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

## Catalog Description:

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

## Text:

<u>Linear Algebra Labs with Matlab</u>, Hill & Zitarelli, 3$^{rd}$ edition
<u>Linear Algebra with Applications</u>, S. Leon, 6$^{th}$ edition

## Topics List:

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

Leon:

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

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

## 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, 3$^{rd}$ edition
Linear Algebra with Applications, S. Leon, 6$^{th}$ edition

## Topics List:

This is a continuation of 571. Chapter 5 of Leon's book will be completed, and Chapters 4 and 6 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 |

Course Coordinator:
Ed Overman
2004-2005

**Mathematics 573**           **5 cr.**           **Elementary Number Theory**
**Sp of odd numbered years**

## Prerequisite:

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

## Catalog Description:

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

## Purpose of Course:

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

## Text:

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

## Topics:

1. Divisibility properties of integers; primes, Euclidean algorithm, unique factorization, greatest common divisors, least common multiples.

2. Linear Diophantine equations.

3. Congruences; Euler's function, Euler-Fermat Theorem, primitive roots.

4. Linear congruences, Chinese Remainder Theorem, quadratic congruences, Quadratic Reciprocity Law.

5. Optional Topics: Pythagorean Triples, sums of squares, cryptography, elliptic curves, higher degree Diophantine equations.

Course Coordinator:
Paul Ponomarev
2004-2005

**Mathemaics 575**          **5 cr.**     **Combinatorial Mathematics & Graph Theory**
**Wi, Sp**

**Prerequisite**: Mathematics 568.

**Catalog Description**: 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, orthonality of latin squares, finite projective planes, block designs, symmetric block designs, Hadamard matrices.

(Over for Topics List)

## Topics List

### 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

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

\*Offered only in the Winter quarter of even years
\*Offered only in the Spring quarter of even years

## Prerequisite:

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

## Catalog Description:

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

### H577:
Continuation of H576.

## Purpose of Course:

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

Texts vary, for example:

An Introduction to the Theory of Numbers, G. Hardy and E. Wright
A Course in Number Theory, (2$^{nd}$ edition), H. Rose
A Friendly Introduction to Number Theory, Silverman
An Introduction to the Theory of Numbers, I. Niven, H.S. Zukkerman, H.L. Montgomery

(over for Suggested Topics List)

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## Suggested Topics List

### H576:

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

2. Famous irrationalities.

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

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

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

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

### H577:

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

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

3. Quadratic reciprocity.

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

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

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

Course Coordinator:
Vitaly Bergelson
2004-2005

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

## Prerequisite:

CSE 201 or 221, and Mathematics 568, and either Mathematics 530 or Statistics 427.

## Catalog Description:

Analysis and solution of various applied problems using discrete mathematical models; methods used include theory of eigenvectors and eigenvalues from linear algebra, 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 Dynamical Systems, Sandefur

## Other References:

Mathematical Modeling, Maki & Thompson;  Applying Mathematics, Burghes, Huntly & McDonald;  Computer Simulation, Nancy Roberts et al, Addison-Wesley;  Applications of Linear Algebra, Anton and 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 and Fox, Brooks/Cole Publishing Company

## 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.  Among the topics could be:

1. Discrete deterministic models developed from numerical data.
2. Markov processes
3. Random processes and Monte Carlo simulation.
4. Linear optimization and the simplex algorithm.
5. Graph theory, including shortest paths, minimum weight spanning trees, and job scheduling.
6. Network flows and the Ford-Fulkerson algorithm for maximum flow.
7. 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.

| Mathematics | 580 Au, Wi | 3 cr. each | Algebra I |
|---|---|---|---|
| | 581 Wi, Sp | | Algebra II |
| | 582 Sp, Au | | Algebra III |

## Prerequisite:

Mathematics 568 (may be taken concurrently with 580) and Mathematics 345.

## 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, geometry, 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:

Notes by R. Solomon

## Topics:

**580:** Theory of equations, elementary number theory, elementary properties of groups, Lagrange's Theorem.

**581:** More elementary number theory, theory of equations, ring theory, group theory, ruler and compass constructions.

**582:** Three-dimensional groups of motions. Some linear algebra. Elements of Galois Theory.

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Course Coordinator:
Ron Solomon
2004-2005

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

### Prerequisite:

$3^{rd}$ 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:

*Actuaries' Survival Guide,* Fred E. Szabo, Elsevier, Inc. 2004.

### Topics:

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

DEPARTMENT OF MATHEMATICS
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Course Coordinator:
Bostwick Wyman
2004-2005

| Mathematics | H590 Au | 5 cr. each | Algebraic Structures I |
| | H591 Wi | | Algebraic Structures II |
| | H592 Sp | | Algebraic Structures III |

## Prerequisite:

H590---H520 with a grade of C or better, or written permission of Honors Committee Chairman.
H591---H590 with a grade of C or better or written permission of Honors Committee Chairman.
H592---H591 with a grade of C or better or written permission of Honors Committee Chairman.

## Catalog Description:

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

## Text vary, for example:

Algebra, M. Artin
Abstract Algebra, 3rd Edition, D. Dummit and R. Foote (used 2004, 2005)
Topics in Algebra, I. Herstein

## Suggested Topics :

### H590:

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

### H591:

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

### H592:

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

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

## Prerequisites:

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

## 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:

Introduction to Linear Algebra, Johnson, Riess & Arnold, (chapter 4)
Linear Algebra and its Applications, Strang 3$^{rd}$ Edition, (chapter 5)

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

(Over for Topics List)

## 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 space

IV.     **EIGENVALUES AND EIGENVECTORS**     (approximately 5 days)

         Eigenvector basis
         Diagonalizing a matrix
         Generalized eigenvectors
         Phase portrait of a system of linear differential equations
         Powers of a matrix
         Markov processes
         Adjoint of an operator

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

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

Course Coordinator:
Ulrich Gerlach
2004-2005

| Mathematics 602 | 3 cr. | Mathematical Principles |
|---|---|---|
| Wi | | in Science II |

**Prerequisite:**

Mathematics 601

**Catalog Description:**

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

**Purpose of Course:**

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

**Follow-up Course:**

Math 603

**Possible Texts and Topics:**

I.  Eigenvalues and eigenvectors:

       Linear Algebra and its Applications, Strang, 3$^{rd}$ edition, (Ch. 5, 6, and Appendix A)

II.  Infinite-dimensional vector spaces:
III.     1. Linear Mathematics in Infinite Dimensions, U. Gerlach, (Ch. 1 and 3)
        2. a) Fourier Series and Boundary Value Problems, Churchill and Brown, (Ch. 3)
           b) Mathematical Methods in Physics and Engineering, Dettman, (Ch. 2)

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

(over for Topics List)

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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)*

Course Coordinator:
Ulrich Gerlach
2004-2005

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

## Prerequisite:

Some complex analysis.  Mathematics 514 would be sufficient.

## Catalog Description:

An introduction to partial differential equations that arise in the mathematical and engineering sciences.

## 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 pdes in 2 and 3 dimensions:
      Partial Differential Equations in Physics, Sommerfeld, (Ch. IV, II)
      Mathematical Methods of Physics, Mathews and Walker, (Ch. 8)

IV. **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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Course Coordinator:
Ulrich Gerlach
2004-2005

**Mathematics 618**  **3 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.

## 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 in Examination FM of the Society of Actuaries and the Casualty Actuarial Society. The course is required for the undergraduate major in actuarial science.

## Text:

*Mathematics of Investment and Credit, 3rd Edition, 2004,* Samuel A. Broverman, ASA, Ph.D. ,Actex Publications.

## 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 interest on a fund, life insurance settlement options, installment loans.
7. Depreciation, depletion, capitalized cost.

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For further information see:
Bostwick Wyman
2004-2005

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

## Prerequisite:

Mathematics 618, and Mathematics 530 or Statistics 520 or equivalent; or permission of instructor.

## Catalog Description:

630: Individual risk models; survival distributions and life tables; life insurance annuities

631: Continuation of 630; net premiums and net premium reserves; multiple life functions; multiple decrement models.

632: The Mathematics 632 syllabus will be revised to match the topics in Society of Actuaries Exams currently under revision.

## Purpose of Courses:

This sequence is designed to introduce students to the mathematical content of the theory of contingencies. The sequence includes some material from several new Examinations of the Society of Actuaries and the Casualty Actuarial Society. The sequence is required for the undergraduate major in actuarial science.

## Text:

Actuarial Mathematics., 2nd edition, Newton L. Bowers, Jr., et al, Society of Actuaries, 1997.

For further information see:
Bostwick Wyman
2004-2005

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

## Prerequisite:

Mathematics 547 or permission of the Graduate Advising Committee.

## Catalog Description:

Riemann-Stieltjes Integral; Uniform Convergence and Interchange of Limit Processes, Special Functions, Fourier Series.

## Purpose of Course:

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

## Text:

A Radical Approach to Real Analysis, by David Bressoud

## Topics:

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

Course Coordinator:
Paul Nevai
2004-2005

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

## Prerequisite:

Permission of Department.

## Catalog Description:

**651:**   Real numbers, infinite sequences and series.

**652:**   Continuous functions, differentiable functions and functions of bounded variation; Riemann-Stieltjes integral.

**653:**   Measurable sets and functions, elementary theory of the Lebesgue integral.

## Purpose of Course:

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

## Follow-up Courses:

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

## Possible Texts:

Introduction to Real Functions and Orthogonal Expansions, B. Sz.-Nagy,
        (used 98-99, 99-00, and 00-01)
        651: Chapter 1, add. mat.; 652: Chapters 2,3,4; 653: Chapters 5,6 and parts of 7 & 8
        [Out of print, but arrangements have been made for the text for the course.]

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

or:
An Introduction to Classical Real Analysis, K. Stromberg, (used 94-95 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, S. Berberian
        651: Chapters 1-4, 10; 652: Chapters 5-9; 653: Chapter 11 and supplementary material
or:
Principles of Mathematical Analysis, 3$^{rd}$ Edition, Rudin

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

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Course Coordinator:
Paul Nevai
2004-2005

| Mathematics | 655 Au | 4 cr. Each | Elementary Topology I |
|---|---|---|---|
| | 656 Wi | | Elementary Topology II |
| | 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, eg. 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, connectedness in metric and general topological spaces, completeness in metric spaces.

### 656:

Continuation of 655; products, quotients, separation axioms, convergence, metrization and compactifications for general topological spaces.

### 657:

Continuation of 656; fundamental group and covering spaces.

(NOTE: The catalog description is obsolete. See below.)

## 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

(over for topics list and texts)

**Possible Texts:**

An Introduction to Algebraic Topology, Rotman
Basic Topology, by M. A. Armstrong, Springer-Verlag, 1994.
A Basic Course in Algebraic Topology, by W. S. Massey, Springer-Verlag, 1991.
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, 2$^{nd}$ ed., by J. R. Munkres, Prentice-Hall, 1999.

## Topics List for Math 655/656/657:

Metric and topological spaces and continuity
Connectedness and path-connectedness
Compactness
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

| Mathematics 665 | 4 cr. | Modern Mathematical Methods |
|---|---|---|
| Mathematics 666 | | In Relativity Theory I, II |

## 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 spacetime; physical interpretations; tensors; exterior calculus, manifolds; Lie deriviatives; parallel transport; torsion; curvature; Cartan's two structureal equations; Cartan-Misner calculus.

### 666:
Energy-momentum tensor; fluid dynamics; Einstein field equations, geometry and dynamics of homogeneous cosmologies; black holes, gravitational collapse, violent astrophysical processes.

## Purpose of Course:

To develop an appreciation and the modern machinery for the description of the spacetime continuum with emphasis on (1) the underlying differential geometric framework of spacetime, 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 spacetime.

## 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

## Topics:

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

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

| Mathematics | 670 Au | 5 cr. each | Algebra I |
| | 671 Wi | | Algebra II |
| | 672 Sp | | Algebra III |

## Prerequisite:

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

## Catalog Descriptions :

### 670:
Examples of groups, subgroups, quotient groups, isomorphism theorems, group actions, class equation, automorphisms, Sylow theorems, direct products, finitely generated abelian groups, introduction to rings and ring homomorphisms, ideals, quotient rings, Chinese remainder theorem. (Chapters 1-5 and 7 in Dummit/Foote were covered in last two years).

### 671:
Continuation of 670: Euclidean domains, principal ideal domains, unique factorization domains, polynomial rings, basics of modules over commutative rings (esp. over PIDs), canonical forms for matrices.
(Chapters 8, 9, 10-12 but skip tensor products, exact sequences, tensor, symmetric and exterior algebras)

### 672:
Continuation of 671: Algebraic extension of fields, ruler and compass constructions, splitting fields, algebraic cosures, cyclotomic polynomials, galois theory for characteristic zero fields, finite fields.

## Purpose of Course:

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

## Text:

Abstract Algebra, Dummit & Foote (used 1995, 2002, 2003)
or
Algebra, Artin (used 1992, 1993, 1994)
or
Topics in Algebra, Herstein.

<div align="center">(Over for Topics List and Sample Syllabus)</div>

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

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

Course Coordinator:
R. Kessar
2004-2005

**Mathematics 701**  **5 cr. Ea**  **Mathematical Principles in Science III:**
**Wi (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
Selected sections from Gravitation by C.S. Misner, K.S. Thorne, and J.A. Wheeler

(Over for Topics List)

## 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

Course Coordinator:
Ulrich Gerlach
2004-2005