Department of Mathematics
The Ohio State University

1993-1994 Mathematics Courses

Course Number	Course Title
50	Pre-College Mathematics I
75	Pre-College Mathematics II
76	Reentry Precollege Math
104	Basic College Mathematics
105	Mathematics for Elementary Teachers I
106	Mathematics for Elementary Teachers II
107	Topics in Mathematics for Elementary Teachers
116	Survey of College Algebra
117	Survey of Calculus
130	Elements of Algebra
131	Elements of Calculus I
132	Elements of Calculus II
148	College Algebra
150	Elementary Functions
151	Calculus and Analytic Geometry
152	Calculus and Analytic Geometry
153	Calculus and Analytic Geometry
254	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
161H	Accelerated Calculus with Analytic Geometry
162H	Accelerated Calculus with Analytic Geometry
263H	Accelerated Calculus with Analytic Geometry
190H	Elementary Analysis I
191H	Elementary Analysis II
264H	Elementary Analysis III
151G	Special Calculus Options 1994-1995
152G	Special Calculus Options 1994-1995

Course Number	Course Title
153G	Special Calculus Options 1994-1995
194	Special Calculus Options 1994-1995
151X	Special Calculus Options 1994-1995
194A	Special Calculus Options 1994-1995
194B	Special Calculus Options 1994-1995
194C	Special Calculus Options 1994-1995
187	Special Calculus Options 1994-1995
255	Differential Equations and Their Applications
294H	Calculus and Analytic Geometry
345	Foundations of Higher Mathematics
366	Discrete Mathematical Structures I
415	Ordinary and Partial Differential Equations
416	Vector Analysis and Complex Variables
471	Matrices and Linear Algebra
487H	Advanced Problem Solving
501	Fundamentals of Mathematics I
502	Fundamentals of Mathematics II
503	Fundamentals of Mathematics III
501S	General Mathematics Review for Students of Actuarial Science
504	History of Mathematics
507	Advanced Geometry
510.01	Topics in Mathematics for Elementary School Teachers
510.02	Topics in Mathematics for Elementary School Teachers
510.03	Topics in Mathematics for Elementary School Teachers
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
531	Probability II
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
556	Differential Equations I

Course Number	Course Title
557	Differential Equations II
558	Differential Geometry of Curves and Surfaces
560	Point-Set Topology
566	Discrete Mathematical Structures II
568	Introductory Linear Algebra I
569	Introductory Linear Algebra II
571	Linear Algebra for Applications I
572	Linear Algebra for Applications II
573	Elementary Number Theory
574	Geometry
575	Combinatorial Mathematics & Graph Theory
578	Discrete Mathematical Models
580	Algebra I
581	Algebra II
582	Algebra III
590H	Algebraic Structures I
591H	Algebraic Structures II
592H	Algebraic Structures III
601	Mathematical Methods in Science I
602	Mathematical Methods in Science II
616	Numerical Methods in Actuarial Mathematics
618	Theory of Interest
630	Mathematics of Life Contingencies I
631	Mathematics of Life Contingencies II
632	Mathematics of Life Contingencies III
650	Principles of Mathematical Analysis
651	Introduction to Real Analysis I
652	Introduction to Real Analysis II
653	Introduction to Real Analysis III
670	Algebra I
671	Algebra II
672	Algebra III
701	Mathematical Methods In Science III

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.

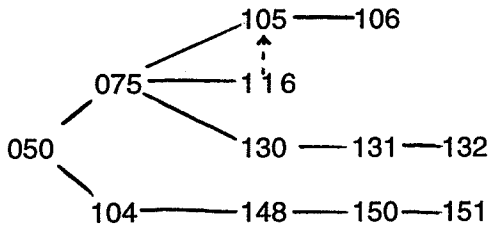
Purpose of Course:

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:



Text:

Essential Algebra: A Calculator Approach, F. Demana and J. Leitzel
(Addison-Wesley, Publishers)
Chapters 1 - 6, 11.1

Possible Study Guide: Schaum's Outline Series -- Modern Elementary Algebra

(Over for Topics)

Topics List & Sample Syllabus

Sections	Topic
1.1-1.7	Numerical Mathematics with a Calculator Using the Calculator including repeated multiplication, negative numbers Distributive property Factoring Whole Numbers into primes Greatest Common Factor and Least Common Multiple
2.1-2.8	Computing with Fractions and Decimals Comparing Fractions and Decimals Adding, Subtracting, Multiplying, Dividing Percent Division Algorithm and Euclidean Algorithm
	Review and 1st Midterm
3.1-3.9	Using Exponents and Scientific Notation Computations including 0 and negative integers as exponents Exponents and Quotients Scientific Notation Round-off and Approximate Solutions Compound Interest Inflation, Compound Interest and other applications Fractional Exponents and square root
4.1-4.3	Using Graphs to Solve Problems Picturing Information, Perimeter, Area Problems Involving Exponents
	Review and 2nd Midterm
4.4-4.5	Using Graphs, continued: Percent Problems, Mixture Problems
5.1-5.7	Linear Equations in One Variable Writing and Solving Equations Problems with Percent, Geometric Figures, Coins, Travel Equations with More than One Variable, Inequalities
6.2-6.3	Graphing Equations in Two Variables Graphs of Polynomial and Rational Equations
	Review and 3rd Midterm
6.4-6.6	Graphing Equations in Two Variables, continued Graphs of Exponential Equations Special and Arbitrary Linear Equations
11.1	Area of Geometric Figures
	Review and Final Exam

For Further Information See:
Sia Wong
1993-94

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. In addition, **students placing at Course Code R** and who need Math 130, must take 075 or 104 prior to enrolling in 130. Completion of Math 075 is required for entry into numerous degree granting colleges; however, credit for 075 will not count toward graduation in any degree granting program. It is designed for students continuing in Math 105, 116, or 130.

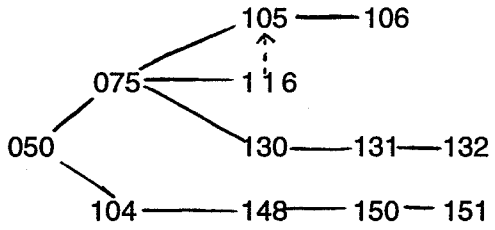
Follow-up Courses:

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

Math 116 for students in liberal arts or elementary education.

Math 130 for students in business.

Sequencing Chart:



Text:

Essential Algebra: A Calculator Approach, F. Demana and J. Leitzel (Addison- Wesley, Publishers). Chapters 6.5, 6.6, 7 - 10, 11.3, 11.6-11.9.

Possible Study Guide: Schaum's Outline Series -- Modern Elementary Algebra

(Over for Topics)

Topics List & Sample Syllabus

Sections	Topics
6.5-6.6	Graphing Equations in Two Variables (review)
7.1-7.6	Linear Equations in Two Variables and Their Graphs Slope of a Line, Equation of a Line Using Graphs to Solve Two Equations in Two Variables Algebraic Methods of Solving Two Equations in Two Variables Systems of Equations in More than Two Variables Linear Inequalities and Systems of Linear Inequalities in Two Variables
8.1-8.2	Polynomial Arithmetic and Factoring Adding, Subtracting, Multiplying Polynomials and Special Products
	Review and 1st Midterm
8.3-8.7	Polynomial Arithmetic and Factoring (continued) Common Factors, Trinomials Differences of Squares, Sums & Differences of Cubes Division and Consequences of Division Factor Theorem
9.1-9.5	Quadratic Equations and Inequalities Graphs of Quadratic Equations in Two Variables Methods of Solving Quadratic Equations in One Variable Square Root and Solutions, Quadratic Formula, Problem Solving
	Review and 2nd Midterm
9.6,9.8	Quadratic Equations: Equations Quadratic in Form, Nonlinear Systems
10.1-10.7 (skip 10.4)	Rational Expressions and Fractional Equations Equivalent Rational Expressions Operations with Rational Expressions Graphing Expressions and Solving Equations and Problems Variation
11.3,11.6	Measurement Geometry and Trigonometry Pythagorean Formula and Distance Formula Trig Ratios in Right Triangles
	Review and 3rd Midterm
11.7-11.9	Measurement Geometry and Trigonometry (continued) Trig Ratios for Acute Angles and Applications Trig Ratios for Angles that are not Acute
	Review and Final Exam

For Further Information See:
Sia Wong
1993-94

Mathematics 076 **4 cr.** **Reentry Precollege Math**
A, W, Sp, Su

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.

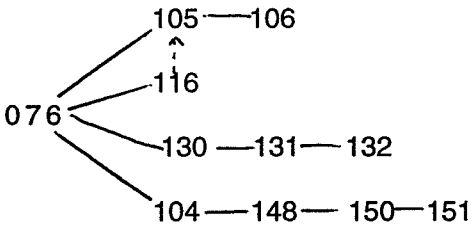
Purpose of Course:

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, 116, or 130. 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, or engineering.
- Math 116 for students in liberal arts or elementary education.
- Math 130 for students in business.

Sequencing Chart:



Text:

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

(Over for Topics)

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
1993-1994

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

Prerequisite:

Mathematics 050, or 075, or Course Code S or 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.

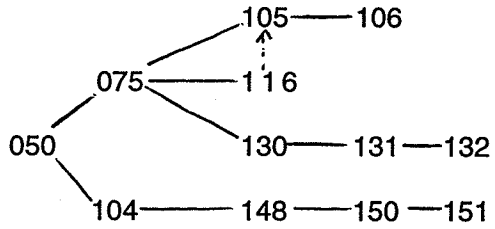
Purpose of Course:

To meet the needs of students entering the University with Course Code S on Math Placement Test, or with credit for 050. In addition, **students placing at Course Code R, and who need Math 148**, must take 104 prior to enrolling in 148. Completion of Math 104 is required for entry into some degree granting colleges.

Follow-up Course:

Math 148.

Sequencing Chart:



Text:

Intermediate Algebra, Applications and Problem Solving, Phillips, Butts and Shaughnessy, (Harper and Row), Chapters 1 - 9

(Over for Topics)

Topics List with Sample Syllabus

Section	Topic
1.4	Inequalities and absolute value
2.3	Polynomials
2.4	Multiplication and division of polynomials
2.5	Algebra as a Language
3.4	Linear inequalities and Absolute Value Inequalities
4.1	Graphs of Lines
4.2	Equations of Lines
4.3	Properties of Linear Graphs
4.4	Linear Systems
	Review and 1st Midterm
5.1	Factoring Polynomials
5.2	Multiplication and Division of Fractions
5.3	Addition and Subtraction of Fractions
5.4	Fractional Equations
6.1	Quadratic Models and their Graphs
6.2	The Solution of Quadratic Equations by Factoring
6.3	Completing the Square and the Quadratic Formula
7.1	Graphing Quadratic Equations
	Review and 2nd Midterm
8.1	nth Roots
8.2	Operations on Rational Exponents
8.3	Operations on Radicals
8.4	Radical and Exponential Equations
9.1	Defining Functions
9.2	Evaluating Functions
9.3	Graphing Functions
	Review and 3rd Midterm
9.4	Finding and Optimizing Functions
	Review and Final Exam

For Further Information See:
Sia Wong
1993-1994

Mathematics 105 **5 cr.** **Mathematics for**
A, W, Sp **Elementary Teachers I**

Prerequisite:

Mathematics 075 or 104, or Course Code L, M, N or R on Math Placement Test.

Catalog Description:

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

Purpose of Course:

To develop an appreciation of, and basic competency in, the use of analytical thought in the development of a cohesive body of useful mathematical knowledge, with special emphasis on topics encountered in the elementary school mathematics program. Math 105 deals with topics encountered in grades K - 4, and in particular introduces the whole number system, geometry, and combinatorial counting techniques. Math 106 introduces rational numbers and integers, congruent and similar triangles, and probability.

Follow-up Course:

Math 106

Text:

Mathematics for Elementary Teachers, 2nd Ed., Musser & Burger, Ch. 1,2,3, 4.2, 5, 11.2.

and

OSU Math 105 Supplements, Ferrar and Leitzel.

Topics:

Section	Topics
1.1	The Problem-Solving Process
2.1	Sets as a Basis for Whole Numbers
Supp. A,B	Sets in Geometry and Measurement
2.2	Whole Numbers and Numeration
3.1	Addition, Subtraction, and Ordering
Supp. C	More Measurement
4.2 (first part)	Written Algorithms for the Addition and Subtraction of Whole Numbers
3.2	Multiplication, Division, and Exponents
4.2 (second part)	Written Algorithms for Multiplication and Division of Whole Numbers
11.2	Probability and Complex Experiments
Topic 3 (in M&B)	Advanced Counting Techniques
5.1	Primes, Composites, and Tests for Divisibility
5.2	Counting Factors, Greatest Common Factor, Least Common Multiple

Course Coordinator:
Joe Ferrar
1993-1994

Mathematics 106 **5 cr.** **Mathematics for**
Au,Wi,Sp **Elementary Teachers II**

Prerequisite:

Mathematics 105

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 the elementary school mathematics program. Math 105 deals with topics encountered in grades K - 4, and in particular introduces the whole number system, geometry, and combinatorial counting techniques. Math 106 introduces rational numbers and integers, congruent and similar triangles, and probability.

Follow-up Course:

Math 107

Text:

Mathematics for Elementary Teachers, 2nd ed., Musser & Burger, Ch. 6,7,8,9,10,11.1,11.3.

and

OSU Math 106 Supplements, Ferrar and Leitzel.

Topics:

Section	Topics
6.1	The Set of Fractions
6.2	Fractions-Operations and Properties
7.1	Decimals and their Operations
7.2	Ratio and Proportion
7.3	Percent
11.1	Probability and Simple Experiments
11.3	Odds, Conditional Probability, Expected Value, and Simulation
8.1	Addition and Subtraction of Integers
8.2	Multiplication and Division of Integers, and Order of Operations
9.1	The Set of Rational Numbers
9.2	The Set of Real Numbers
Supp. F	Geometry Supplement

Course Coordinator:
Joe Ferrar
1993-1994

Mathematics 107 **5 cr.** **Topics in Mathematics**
Wi **For Elementary Teachers**

Prerequisite:

Mathematics 106

Catalog Description:

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

Topics:

Optional with instructor. Should closely relate to content of 105 and 106 and serve to tie together topics previously encountered. A problem-solving approach using microcomputers is highly appropriate.

Course Coordinator:
Joe Ferrar
1993-1994

Mathematics 116 **5 cr.** **Survey of College Algebra**
A, W, Sp, Su

Prerequisite:

Mathematics 075 or 104, or Course Code R on Math Placement Test.

Catalog Description

The sequence 116, 117 treats topics applicable to non-physical sciences. Topics in 116 include college algebra, analytic geometry, linear algebra, and linear programming.
(But this description is not accurate for the text used 1993-94.)

Purpose of Course:

The emphasis in this course is on intuitive understanding and developing some facility for applying mathematical ideas to problem solving. It is hoped that students may feel less intimidated by terminology and symbolism. 116 and 117 should give the students an overview of college algebra and differential and integral calculus. The applications are selected from business and economics, and the life and social sciences.

Follow-up Courses:

Students under the GEC majoring in elementary education will need to take 116 before being admitted to the program, and will then have to take 105 and 106.

For most other students in 116, there is no follow-up course.

Students interested in programs that require 130 or 148 should not take 116. If a student takes 116 and changes to business (or other program requiring 130), the student may proceed with caution to 130 if the student is able to do the material in chapters 0 and 1 of the 130 text (otherwise the student should go to 104 first). Students who take 116 and change to programs requiring 148 must take 104 (or alternatively pass the 104 proficiency exam) before taking 148.

Important notes:
(i) Students who were originally Course Code N may always take 130 or 148 after 116, without having to do 104 first. It is only the Course Code R students who take 116 that will need 104 before moving ahead.

(ii) The Math Department will recommend waiving the exclusion clauses on taking 104 and/or 130 for credit for all students in those situations described above.

Text:

Finite Mathematics, An Applied Approach, 1st Edition, Long & Graening (Text used beginning Autumn 1993; replaces Barnett and Ziegler text.)

(Over for Topics)

Topics list & Sample Syllabus

Section	Topics
1.1	The Cartesian Plane and Graphing
1.2	Equations of Straight Lines
1.3	Linear Modeling
1.4	Two Lines: Relating the Geometry to the Equations
1.5	Regression and Correlation
2.1	Linear Systems and Mathematical Models
2.2	Linear Systems Having One or No Solutions
2.3	Linear Systems Having Many or No Solutions
	1st Midterm
3.1	Matrix Addition and Applications
3.2	Matrix Multiplication and Applications
3.3	The Inverse of a Matrix
3.4	More Applications of the Inverse
4.1	Modeling Linear Programming Problems
4.2	Linear Inequalities in Two Variables
4.3	Solving Linear Programming Problems Graphically
4.4	Slack Variables and Pivoting
4.5	The Simplex Algorithm
	2nd Midterm
5.1,5.2	Logic & Sets
5.3	Applications of Venn Diagrams
5.4	The Multiplication Principle
5.5	Permutations and Combinations
6.1	Defining Probability
6.2	Events and Odds
6.3	Mutually Exclusive Events
6.4	Conditional Probability
8.1	Combining Matrices with Probability: The Transition Matrix
	3rd Midterm*
	Final Exam

* In Autumn 93, there were three midterms, but later there were only two during the quarter.

Course Coordinator:
Tom Ralley
1993-1994

Mathematics 117 **5 cr.** **Survey of Calculus**
A, W, Sp, Su

Prerequisite:

Mathematics 116 or 130 or 148 or 150

Catalog Description:

An introduction to differential and integral calculus.

Purpose of Course:

Under the GEC the majority of the audience is made up of Architecture majors for whom the course is a requirement, with the balance being Exercise Science, Elementary Ed, and pre-GEC students from Arts & Sciences. The intent of the course is to introduce these students to the derivative and definite integral, using the slope of the tangent line or rate of change as a conceptual model for the derivative and area as a model for the definite integral. For this audience, graphical examination of these ideas is helpful.

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, Hughes-Hallett, Gleason et. al. (produced by the Calculus Consortium based at Harvard Univ.).

This text was first used in 117 in Autumn 1993, replacing Barnett & Ziegler.

(Over For Topics List And Sample Syllabus)

Topics List & Sample Syllabus

Section	Topics
1.1	Functions and their graphs, more on functions
1.2	Linear functions $f(x)=mx+b$
1.3	Exponential functions $f(x)=B^x$
1.4	Power functions $f(x)=x^p$
1.5	Inverse functions
1.6	Logarithmic functions $f(x)=\log_B(x)$
1.7	Euler's e; log & exponential functions base e
1.10	Trigonometric functions
	Review and Midterm #1
2.1	Measuring speed
2.2	The derivative at x
2.3	The derivative as a function
2.4	Interpretations of the derivative
2.5	The 2nd derivative
2.6	Approximation and local linearity
2.7	Notes on limits
	Review and Midterm #2
3.1	Finding distance when velocity is known
3.2	The definite integral
3.3	The definite integral as a measure of area
3.4	The Fundamental Theorem of Calculus
3.5	More on limits

Review and Final Exam

Course Coordinator:
Tom Ralley
1993-1994

Mathematics 130 **4 cr.** **Elements of Algebra**
A, W, Sp, Su

Prerequisite:

Mathematics 075 or 076 or 104, or Course Code N on Math Placement Test.

Catalog Description:

Equations, inequalities, absolute value, functions, exponential and logarithmic functions, systems of equations, and matrix algebra.

Purpose of Course:

To provide students with the pre-calculus mathematics needed in the 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, Ernest F. Hauessler and Richard S. Paul, 7th Edition, Chapters 2,3,4,5,8, and supplements for the material in Chapter 3.

Topics:

Linear Inequalities, Absolute Value (2.2, 2.4)
Applications of Equations, Applications of Inequalities (2.1, 2.3)

Functions, Special Functions (3.1, 3.2)
Combinations, Graphs in Rectangular Coordinates (3.3, 3.4, supplement)
Symmetry (3.5, supplement)

Lines, Applications and Linear Functions (4.1, 4.2)
Quadratic Functions (4.3)

Exponential Functions (5.1)
Logarithmic Functions, Properties of Logarithms (5.2, 5.3)
Logarithmic and Exponential Equations (5.4)

Compound Interest (8.1)
Present Value (8.2)
Annuities (8.3)
Amortization of Loans (8.4)

Systems of Linear Equations, Nonlinear Systems (4.4, 4.5)
Applications of Systems of Equations (4.6)

Course Coordinator:
Gloria Woods
1993-1994

Mathematics 131 **4 cr.** **Elements of Calculus I**
A, W, Sp, Su

Prerequisite:

Mathematics 130 or 148 or 150, or Course Code L on Math Placement Test. (Note: students who took 116 in Autumn 1993 or later are not prepared for 131.)

Catalog Description:

Limits, tangent lines, derivatives, logarithmic and exponential functions, graphing techniques, applications of calculus to business.

Purpose of Course:

The 131 and 132 courses are designed to introduce students in the College of Business to differential and integral calculus and related business applications. These courses are problem oriented and little rigor is introduced.

Follow-up Course:

Math 132

Text:

Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, Ernest F. Hauessler and Richard S. Paul, 7th Edition, chapters 11-14 and 15.1.

This text was used for the first time in Winter 1994; in Autumn 1993 the 6th edition was used (same topics were covered).

TOPICS

Limits	(11.1,11.2)
Interest Compounded Continuously, Continuity	(11.3,11.4)
Continuity Applied to Inequalities	(11.5)
The Derivative	(12.1)
Rules for Differentiation, Derivatives as a Rate of Change	(12.2,12.3)
Differentiability and Continuity, Product & Quotient Rules	(12.4,12.5)
The Chain Rule and Power Rule, Derivatives of Logarithmic Functions	(12.6,13.1)
Derivatives of Exponential Functions, Implicit Differentiation	(13.2,13.3)
Logarithmic Differentiation, Higher Order Derivatives	(13.4,13.5)
Relative Extrema	(14.1)
Absolute Extrema on a Closed Interval	(14.2)
Concavity, The Second Derivative Test	(14.3, 14.4)
Asymptotes	(14.5)
Applied Maxima and Minima	(15.1)

Course Coordinator:
Surinder Sehgal
1993-1994

Mathematics 132 **4 cr.** **Elements of Calculus II**
Au, Wi, Sp, Su

Prerequisite:

Mathematics 131 or 117 or 151

Catalog Description:

Anti-differentiation, definite integral, integral of the logarithmic and exponential functions, techniques of integration, areas, differential equations, functions of several variables, partial derivatives, extrema, Lagrange multipliers, applications of calculus to business.

Purpose of Course:

The 131 and 132 courses are designed to introduce students in the College of Business to differential and integral calculus for one and several variables and related business applications. The courses are problem oriented and little rigor is introduced.

Follow-up Courses:

Stat 133 for most students in Business.

Math 150 for those students switching majors and needing the main-line calculus sequence.
CAUTION: Students completing 132 may **not** enroll in 153.

Text:
Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, E. Hauessler and R. Paul, 6th edition (through Wi 94); 7th edition (first used in 132 for Sp 94).

Topics List & Sample Syllabus

	6th ed. (Au,Wi)	7th ed. (Sp,Su)
Indefinite Integral, Integration With Initial Conditions	(15.1, 15.2)	(16.1, 16.2)
More Integration Formulas	(15.3)	(16.3)
Techniques of Integration	(15.4)	(16.4)
The Fundamental Theorem of Integral Calculus	(15.7)	(16.7)
Area, Area Between Curves	(15.8-15.9)	(16.8-16.9)
Consumers and Producers Surplus	(15.10)	(16.10)
Review and Midterm #1		
Integration by Parts	(16.1)	(17.1)
Integration by Tables	(16.3)	(17.3)
Average Value, Approximate Integration	(16.4, 16.5)	(17.4, 17.5)
Differential Equations	(16.6)	(17.6)
Improper Integrals	(16.8)	(17.8)
Review and Midterm #2		
Functions of Several Variables	(18.1)	(19.1)
Partial Derivatives	(18.2)	(19.2)
Applications of Partial Derivatives, Higher-Order Partials	(18.3, 18.5)	(19.3, 19.5)
Maxima and Minima	(18.7)	(19.7)
Review and Midterm #3		
Lagrange Multipliers	(18.8)	(19.8)
Review and Final Exam		

Course Coordinator:
Thomas Schwartzbauer
1993-1994

Mathematics 148 **4 cr.** **College Algebra**
A, W, Sp, Su

Prerequisite:

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

Catalog Description:

Rational exponents, inequalities, functions, graphs of polynomial and rational functions, conic sections, zeros of polynomials.

Purpose of Course:

The two courses, Math 148 and 150, consist of precalculus concepts and skills needed by the student entering the regular calculus sequence (151, 152, etc.). The purpose of the two courses is to prepare the student for the regular calculus sequence.

Follow-up Course:

Math 150

Text:

Fundamentals of Algebra and Trigonometry (8th ed.), Swokowski and Cole.
(first used Autumn 1993)

Topics:

Real Numbers	(1.1)
Quadratic Equations	(2.3)
Complex Numbers, Other Types of Equations	(2.4, 2.5)
Inequalities	(2.6)
More on Inequalities	(2.7)
Rectangular Coordinate Systems	(3.1)
Graphs of Equations	(3.2)
Definition of Function	(3.4)
Graphs of Functions	(3.5)
Quadratic Equations	(3.6)
Operations on Functions, Inverse Functions	(3.7,3.8)
Graphs of Polynomial Functions of Degree Greater than 2	(4.1)
Properties of Division	(4.2)
Zeros of Polynomials	(4.3)
Complex and Rational Zeros of Polynomials	(4.4)
Rational Functions	(4.5)
Angles, Trigonometric Functions of Angles	(6.1,6.4)

Course Coordinator:
Sia Wong
1993-1994

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:

The two courses, Math 148 and 150, consist of precalculus concepts and skills needed by the student entering the regular calculus sequence (151, 152, etc.). The purpose of the two courses is to prepare the student for the regular calculus sequence.

Follow-up Course:
Math 151

Text:
Beginning Winter 1994:
Fundamentals of Algebra and Trigonometry (8th edition), Swokowski and Cole.

For Autumn 1993, the 2nd edition of Demana, Waits and Clemens (chapters 6-10) was used.

Topics:

Exponential Functions	(5.1)
The Natural Exponential Function	(5.2)
Logarithmic Functions	(5.3)
Properties of Logarithms	(5.4)
Exponential and Logarithmic Equations	(5.5)
Angles	(6.1)
The Trigonometric Functions	(6.2)
Graphs of the Trigonometric Functions	(6.3)
Trigonometric Functions of Angles	(6.4)
The Inverse Trigonometric Functions	(7.6)
Values of the Trigonometric Functions	(6.5)
Trigonometric Graphs	(6.6)
Applications Involving Right Triangles	(6.8)
Verifying Trigonometric Identities	(7.1)
Trigonometric Equations	(7.2)
The Addition and Subtraction Formulas	(7.3)
Multiple Angle Formulas	(7.4)
The Law of Sines	(8.1)
The Law of Cosines	(8.2)
Trigonometric Form of Complex Numbers	(8.3)
DeMoivre's Theorem and nth Root of Complex Numbers	(8.4)
Vectors	(8.5)
The Dot Product	(8.6)

Course Coordinator:
Peter March
1993-1994

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

Prerequisite:

Mathematics 150 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, Finney and Thomas.
Portions of Chapter 1; Chapters 2, 3, 4.

Topics:

Section	Topics
1.2, 1.3	Review of Slopes, Lines, Functions and Graphs
1.4, 1.5	Review of Analytic Geometry, Trig Functions
1.6	Review of Absolute Value and Target Values
2.1	Limits
2.2	The Sandwich Theorem and $(\sin \theta)/\theta$
2.3	Limits Involving Infinity
2.4	Continuous Functions
2.5	Formal Definition with Epsilons and Deltas
3.1	Slopes, Tangent Lines, Derivatives
3.2	Differentiation Rules
3.3	Velocity, Speed, Rates of Change
3.4	Derivatives of Trigonometric Functions
3.5	The Chain Rule
3.6	Implicit Differentiation and Fractional Powers
3.7	Linear Approximations and Differentials
3.8	Newton's Method
4.1	Related Rates of Change
4.2	Maxima, Minima, and the Mean Value Theorem
4.3-4.4	Curve Sketching--y', y", rational functions, asymptotes
4.5	Optimization
4.6	Antiderivatives, Initial value problems

Course Coordinator:
Frank Carroll
1993-94

Mathematics 152 **5 cr.** **Calculus and Analytic Geometry**
A, W, Sp, Su

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, Finney and Thomas, Chapters 5,6,7,8.

Sections	Topics
5.1,5.2	Area under a curve, finite sums
5.3	Definite integrals
5.4	Fundamental Theorem
5.5, 5.6	Indefinite integrals, substitution
5.7	Numerical integration
5.8	Brief intro to logarithms and exponentials
6.1, 6.2	Areas between curves; solids of revolution
6.3, 6.4	Cylindrical shells; lengths of curves
6.5, 6.6	Areas of surfaces of revolution; work
6.7	Fluid pressures and fluid forces
6.8	Centers of Mass
6.9	Applications
7.1, 7.2	ln x, e^x; logarithmic differentiation
7.3, 7.4	$\log_a x$, a^x; growth and decay
7.5, 7.6	Indeterminate Forms and l'Hôpital's rule
7.7, 7.8	Inverse trig functions
7.8, 7.9	Derivatives of inverse trig functions
8.1, 8.2	Basic integration formulas; by parts
8.3	Trigonometric integrals
8.4	Trigonometric substitutions
8.5	Rational functions and partial fractions
8.6	Using integral tables
8.7	Improper integrals

Course Coordinator:
Frank Carroll
1993-94

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

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, Finney and Thomas, Chapters 9,10,11.

Sections	Topics
9.1	Limits of sequences of numbers
9.2	Infinite series
9.3	Comparison and integral tests
9.4	Root and ratio tests
9.5	Alternating series and absolute convergence
9.6	Power series
9.7	Taylor and Maclaurin series
9.8	Further calculations with Taylor series
10.1	Conic sections and quadric equations
10.2	The graphs of quadric equations in x,y
10.3	Parametric equations for plane curves
10.4	The calculus of parametric equations
10.5	Polar coordinates
10.6	Graphing in polar coordinates
10.8	Integration in polar coordinates
11.1	Vectors in the plane
11.2	Coordinates and vectors in space
11.3	Dot products
11.4	Cross products
11.5	Lines and planes in space
11.6	Surfaces in space
11.7	Cylindrical and spherical coordinates

Course Coordinator:
Ted Scheick
1993-94

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

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, Finney and Thomas, Chapters 12,13,14,15.1-15.3

Sections	Topics
12.1	Vector functions and curves in space
12.2	Projectile motion
12.3	Directed distance and the unit tangent vector
12.4	Curvature, torsion and the TNB frame
13.1	Functions of 2 or more variables
13.2	Limits and continuity
13.3	Partial derivatives
13.4	The chain rule
13.5	Directional derivatives and gradient vectors
13.6	Tangent planes and normal lines
13.7	Linearization and differentials
13.8	Maxima, minima, and saddle points
13.9	Lagrange multipliers
14.1	Double integrals
14.2	Area, moments
14.3	Double integrals in polar form
14.4	Triple integrals in rectangular coordinates
14.5	Masses and moments in 3 dimensions
14.6	Triple integrals in cylindrical and spherical coordinates
14.7	Substitutions in multiple integrals
15.1	Line integrals
15.2	Vector fields, circulation and flux
15.3	Green's Theorem in the plane

Course Coordinator:
Ted Scheick
1993-1994

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

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 for about two hours per day 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.

Text:

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

For further information see:
William Davis
1993-1994

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

Catalog Descriptions:

(NOTE: Although the below are the current catalog descriptions, they do not accurately reflect the current arrangement of material in these courses. See the "Topics" section below for a more accurate description.)

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

162:
Techniques of integration; improper integrals; applications of the integral; polynomial approximations and Taylor's Theorem; infinite sequences and series; tests for convergence; vectors, lines and planes.

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

Prerequisite:

Math 161--- Course code L placement and high school calculus.
Math 162--- 161 or written permission of department.
Math 263--- 162 or written permission of department.

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.

Follow-up Course:

Courses in differential equations or linear algebra (after completing 263).

Text:

Calculus with Analytic Geometry, G. Simmons.

(NOTE: The textbooks for the Math 161 sequence and Math 151 sequence are not the same.)

Topics:

Math 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.

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

Math 263-Vectors, surfaces, cylindrical and spherical coordinates, partial derivatives, multiple integrals, line integrals, vector fields, Green's theorem.

Course Coordinator:
Monique Vuilleumier
1993-1994

Mathematics H161 Au **5 cr.** **Accelerated Calculus**
Mathematics H162 Wi **5 cr.** **and Analytic Geometry**
Mathematics H263 Sp **5 cr.**

Catalog Description:

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

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

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.

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.

Follow-up Course:

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

Text:

Calculus with Analytic Geometry, Simmons (same text as used for 161-162-263).

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

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.

Course Coordinator:
Yung-Chen Lu (Honors)
1993-1994

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

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.

Prerequisite:

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

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:

Calculus, Spivak -for H190, H191.

Vector Calculus, 3rd. ed., Marsden and Tromba -for H264

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.

For Further Information see:
Yung-Chen Lu (Honors)
1993-1994

SPECIAL CALCULUS OPTIONS 1993-1994

1) Math 151G, 152G, 153G

151G - Au 93, 152G - Wi 94, 153G - Sp 94

Purpose: These sections of 151-152-153 covered the same topics as the regular courses, but required the use of graphing calculators.

Text: Finney & Thomas, Calculus - A Graphing Approach (vol. 1&2). This is the graphing calculator version of the regular Finney & Thomas text.

Topics: The topics were the same as in the regular sequence, and students were free to switch into or out of the main sequence at ant time.

For Further Information See:
Frank Demana
1993-1994

2) Math 194, 151X

194 - Au 93, 151X - Wi 94

Purpose: This two quarter calculus-with-review was offered on a pilot basis in 1993-94. The class was intended for first quarter students who (i) needed Math 151 or higher for their intended major, and (ii) placed at level N (and thus would otherwise have to take three math classes to get through Math 151). This pilot sequence gave these students an opportunity to move ahead more quickly by studying precalculus and calculus together.

Prerequisite: Level N placement (i.e. placement into Math 148). High school calculus experience recommended.

Text: Finney & Thomas, Calculus (the same book as in 151-2-3-254). Graphing calculators were highly recommended.

Topics: By the end of 151X, the sequence covered through chapter 4 in Finney & Thomas. The standard precalculus topics were studied as they became necessary for the calculus topics.

Follow-up Course: 152 for students successfully completing both 194 and 151X. Students failing or dropping out of the sequence at any time had to meet with the course instructor and the math counselors for rerouting specific to their situation.

For Further Information See:
Bostwick Wyman
1993-1994

(OVER)

Lima Campus
194A - Au 93
194B - Wi 94
194C - Sp 94
} 050, 075

3) ENG 194A, 194B, 194C

194A - Au 93, 194B - Wi 94, 194C - Sp 94

Purpose: These classes were part of the College of Engineering's Gateway Program, in which selected students studied core topics for the engineering curriculum in an integrated format. The calculus was included with engineering mechanics in the classes 194A, 194B, 194C.

Prerequisite: The courses were limited to outstanding students individually chosen by the College of Engineering.

Text: Finney & Thomas, Calculus (text used in 151-2-3-254).

Topics: The courses did the following sections from Finney and Thomas:

ENG 194A: 2-6, 10, 11	(=all of 151, half of 152 and 2/3 of 153)
ENG 194B: 7-8, 12, 14, 13.1-13.4	(=the rest of 152 and half of 254)
ENG 194C: 13.3-13.9, 15.1-15.3,9, 16.1-16.7	(=rest of 153, rest of 254, additional topics)

The order of topics will be slightly different in 1994-1995.

For Further Information See:
Ted Scheick
1993-1994

4) Math 187

Au, Wi, Sp

NOTE: (i)This is not H187. Math H187 did not run independently on main campus in Au 91, Au 92, or Au 93, but was instead combined with H487; (ii) in 91-92 this class ran as Math 294 but has been 187 in 92-93 and 93-94

Purpose: Companion course to Math 151-2-3 for Minority students in the College of Engineering to provide extra problem solving and supplementary material.

Prerequisite: Minority students in ENG eligible for 151 in Au, 152 in Wi, 153 in Sp.

Text: Finney & Thomas, Calculus (text used in 151-2-3-254) with supplementary material.

Topics: Chosen by instructor to supplement topics in 151-2-3.

For Further Information See:
Dan Okoli (College of Engineering) or
Joe Mourad (Math)
1993-1994

Mathematics 255 **5 cr.** **Differential Equations**
A, W, Sp, Su **and Their Applications**

Prerequisite:

Mathematics 254. Not open to students with credit for 256, 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 (5th edition), Boyce and DiPrima; Chapters 2, 3, 4, 5, 6.

Suggested Syllabus

Chapters	Topics	Approximate Time
2.1-2.5, 2.8-2.9	First Order Differential Equations	1-2 weeks
3.1-3.7	Second Order Linear Equations	1-2 weeks
4.1-4.3	Higher Order Linear Equations	1 week
5.1-5.8	Series Solutions of Second Order Linear Equations	2 weeks
6.1-6.5	The Laplace Transform	2 weeks

Review and additional topics can be added as time permits.

Course Coordinator:
Yuval Flicker
1993-1994

Mathematics H294 **2 cr.** **Calculus and Analytic Geometry**

THIS COURSE RAN AU91 AND WI92 WITH VERY LOW ENROLLMENT. IT DID NOT CONTINUE SP 92, NOR HAS IT BEEN OFFERED SINCE.

Prerequisite:

For Au 91-Concurrent enrollment in 151 or 151C.

Catalog Description:

Designed to give groups of able students an opportunity to pursue special studies not otherwise offered.

Purpose of Course:

This course is designed as an honors supplement to the Math 151-152-153 and 151C-152C-153C sequences and is intended for talented and interested students. The emphasis will be on challenging problems related to calculus, and the course will also introduce some theory. It will meet once a week in the late afternoon, and will be available each quarter for the students who started with 151 or 151C and continued in the sequence.

Follow-up Course:

For the 91-92 school year, H294 will be available each quarter for students who start in 151 or 151C in Autumn 91 and continue in the sequence.

Text:

Calculus, Finney and Thomas. (This is the text used for 151-254.)

Course Coordinator:
No Longer Offered

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:

A Transition to Advanced Mathematics, Smith, Eggen, and St. Andre.

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.

(Over for Topics)

Topics:

Truth tables, Quantifiers, Dummy variables, Set-builder notation.
Elementary set-theoretic identities and inclusions. (Practice with proofs and with translation between set notation and logical notation.)
Russell's paradox and its resolution.
Ordered pairs, Relations, Functions.
Indexed families of sets, Cartesian products, B^A.
Natural numbers, Induction.
Cardinality.
Finite sets, Arithmetic of natural numbers.
Infinite sets. (Aristotle, Galileo, Bolzano, Cantor, Dedekind.) Hilbert's hotel.
Countable sets. Card($\mathbb{Q}$)=Card($\mathbb{N}$).
Cantor's proof that "most" real numbers are transcendental.
Card ($\mathbb{R}$)=Card($2^{\mathbb{N}}$). Card($\mathbb{R}$)=Card($\mathbb{R}^n$)=Card($\mathbb{R}^{\mathbb{N}}$).
Continuum hypothesis. (Cantor, Godel, Cohen.)
Card(A)<Card(2^A). Cantor's paradox and its resolution.
Schroeder-Bernstein theorem.
Equivalence relations, Partitions.
Congruences, gcd, Euclidean algorithm.
Partial order relations, Upper bounds, Lower bounds, Least upper bounds, Greatest lower bounds, Order completeness, Linear order relations, Cuts.
Semigroups, $\mathbb{N}$.
Groups, Rings, $\mathbb{Z}$.
Fields, $\mathbb{Q}$, $\mathbb{R}$.
Ordered fields, Archimedean property, Completeness, Characterization of $\mathbb{R}$ up to isomorphism.
A closer look at decimal expansions. (Also binary, ternary.)
Completion of proof that Card($\mathbb{R}$)=Card($2^{\mathbb{N}}$).
$\mathbb{C}$.
$\mathbb{Z}/n$, $\mathbb{Z}/p$.
The metric on $\mathbb{R}^n$.
Topology of $\mathbb{R}^n$: open sets, interior points, interior of a set; closed sets, closure of a set; boundary points, boundary of a set; accumulation points, derived set of a set, perfect sets.
The Cantor set.
Other examples of complicated sets.
Introduction to limits of sequences.

(This list of topics should be regarded as a "menu" to choose from. There is more material here than can possibly be covered in one quarter.)

Course Coordinator:
Neil Falkner
1993-1994

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

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 CIS faculty is that it present math in rigorous form and require students to deal with abstract systems and mathematical proofs.

Follow-up Course:

Math 566.

Text:

Discrete Mathematics and its Applications, Rosen

Topics:

Chapter 1 Logic, Sets and Functions

- 1.1 Logic
- 1.2 Propositional Equivalences
- 1.3 Predicates and Quantifiers
- 1.4 Sets
- 1.5 Set Operations
- 1.6 Functions
- 1.7 Sequences and Summations

Chapter 3 Mathematical Reasoning

- 3.1 Methods of Proof
- 3.2 Mathematical Induction
- 3.3 Recursive Definitions

Chapter 4 Counting

- 4.1 The Basics of Counting
- 4.2 The Pigeonhole Principle
- 4.3 Permutations and Combinations
- 4.4 Discrete Probability
- 4.5 Probability Theory
- 4.6 Generalized Permutations and Combinations
- 4.7 Generating Permutations and Combinations

Chapter 6 Relations

- 6.1 Relations and their properties
- 6.5 Equivalence Relations

Chapter 9 Boolean Algebra

- 9.1 Boolean Functions
- 9.2 Representing Boolean Functions
- 9.3 Logic Gates
- 9.4 Minimization of Circuits

Course Coordinator:
Tom Dowling
1993-1994

Mathematics 415 **4 cr.** **Ordinary and Partial**
A, W, Sp, Su **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, 5th edition, Boyce and DiPrima.

Topics:

2.1,2.2	Linear first order differential equations
2.3,2.4	Separable equations; differences between linear and non linear equations
2.5,2.6,2.7	Selected applications in population dynamics and mechanics
2.8,2.9,2.10	Exact equations, integrating factors, homogeneous equations; applications
3.1,3.2	Homogeneous equations with constant coefficients; fundamental solutions
3.3,3.4	Linear independence, the Wronskian; complex roots of characteristic equation
3.5	Repeated roots; reduction of order
3.6	Non homogeneous equations; method of undetermined coefficients
3.7	Variation of parameters
3.8,3.9	Mechanical and electrical vibrations; forced vibrations
4.1-4.4	Higher order linear equations
5.1,5.2	Power series; series solutions near an ordinary point
5.3,5.4	More on series solutions near an ordinary point; regular singular points
5.5,5.6	Euler equations; series solutions near a regular singular point
5.7,5.8	More on series solutions near a regular singular point
5.9	Bessel's equation
10.1	Separation of variables; heat conduction
10.2,10.3	Fourier Series; Fourier Theorem
10.4,10.5	Even and odd functions; solution of other heat conduction problems
10.6	The wave equation: vibrations of an elastic string

Course Coordinator:
Frank Carroll
1993-1994

Mathematics 416 **5 cr.** **Vector Analysis and Complex Variables**
Au

(Note: did not run Au 92 or Au 93 due to low enrollment. The course is no longer required for AAE.)

Prerequisite:

Mathematics 254

Catalog Description:

Vector algebra and vector operators, line integrals, analytic functions, complex integral theorems, power series, residues, and conformal mapping.

Purpose of Course:

The course is an option in some engineering programs (mainly Engineering Physics). Minimal proofs or intuitive explanations should be the rule (e.g., Cauchy Theorem by Green's Theorem rather than Cauchy-Goursat). The vector analysis portion should be covered first. This course is a combination of 513 (vector calculus) and 514 (complex variables).

Texts:

Complex Variables, Churchill, Brown
Chapters 1 - 7

Schaum's Outline: Vector Analysis.
Chapters 1 - 6

Topics List:

Comment -- Use first 3 weeks of quarter for vector analysis. Line integrals and Green's Theorem needed for complex variables. Gauss and Stokes Theorems needed for engineering courses taken concurrently. Run as a problem course. Minimal proofs.

Schedule: Vector Analysis

Chap. 1 - 4 Vectors, Dot and Cross Product, Vector Differentiation -- treat as review (4 classes)
Chap. 5 Vector Integration, including independence of path (5 classes)
Chap. 6 Divergence Theorem, Gauss, Green, Stokes Theorems. Omit p. 107 (5 classes)

Schedule: Complex Variables

Chap. 1 Complex Numbers (3 classes)
Chap. 2 Analytic Functions (4 classes)
Chap. 3 Elementary Functions (4 classes)
Test
Chap. 4 Mapping by Elementary Functions (5 classes)
Chap. 5 Integrals (5 classes)
Chap. 6 Power Series (4 classes)
Test
Chap. 7 Residues and Poles (6 classes)

Course Coordinator:
Herb Walum
1993-1994

Mathematics 471 **5 cr.** **Matrices and Linear Algebra**
Wi

COURSE NOT CURRENTLY OFFERED.
COURSE CANCELED WI 93 DUE TO LOW ENROLLMENT;
NOT OFFERED WI 94

Prerequisite:

Mathematics 153; not open to students with credit for 568, 571, or 576.

Catalog Description:

Matrices, systems of equations, $\mathbb{R}^n$, determinants; vector spaces; applications.

Purpose of Course:

The purpose of the course is to provide an elementary introduction to the concepts, vocabulary, notation, and results of matrix and linear algebra. It does not contain the depth of material of H520, 568, 569 or 571. Further, emphasis is placed on the topics as tools rather than as development of structure; 4 - 5 weeks are devoted to linear programming.

NOTE: The class is no longer required for the CIS/Business program.

Text:

To be determined. Handouts by Wyman and Childress are often used.

Linear Programming, Chvatal, Vasek, was used in 1984-85.

Elementary Linear Programming with Applications, Kolman, was used in 1986-87.

Topics:

Matrices -- arithmetic, inverse, transpose, rank;

Systems of equations -- homogeneous and nonhomogeneous;

Convex sets, basic feasible solutions, extreme points

Linear Programming

Course Coordinator:
Not Currently Offered

Mathematics H487 **2 cr.** **Advanced Problem Solving**
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.

Course Coordinator:
Yung-Chen Lu (Honors)
1993-1994

Mathematics	**501**	**4 cr. each**	**Fundamentals of Mathematics I**
	502		**Fundamentals of Mathematics II**
	503		**Fundamentals of Mathematics III**

NO LONGER OFFERED
501-502 LAST OFFERED AU 88, WI 89
501S LAST OFFERED WI 90
COURSES WILL BE REMOVED FROM UNIV. BULLETIN FOR 1994-1995

Prerequisite:

Written permission of department.

Catalog Description:

The integrated sequence 501, 502, and 503 covers the calculus of one and several variables.

Purpose of Course:

This sequence is intended for graduate students in areas other than the mathematical and physical sciences. These courses are graded S/U.

Topics:

This is an integrated sequence in calculus, with topics from algebra and analytic geometry introduced as needed. The course content is essentially the same as the mathematics sequence 151, 152, 153 and 254, with the exception that some of the theory is deleted and the emphasis is on applications to statistics, economics and social sciences.

Content includes lines, slopes, limits, derivatives, applications of derivatives to curve sketching, maxima and minima, approximations; antidifferentiation, the definite integral, Fundamental Theorem of Calculus; area, volume, other applications of integration; logarithmic, exponential, trigonometric and inverse trigonometric functions; integration techniques; indeterminate forms; improper integrals; Taylor's formula; infinite series; differential calculus of functions of several variables; multiple integration.

NOTE: 502 and 503 have not been offered since 1988-89. The department intends to withdraw these courses in the near future.

Mathematics 501S **4 cr.** **General Mathematics Review for Students of Actuarial Science**
W -- Saturdays

NO LONGER OFFERED
501S WAS LAST OFFERED WI 90
WILL BE REMOVED FROM UNIVERSITY BULLETIN FOR 1994-95

Prerequisite:

Permission of department.

Purpose of Course:

The specific topics chosen for this course are those covered on the general mathematics examination (the first examination) of the Society of Actuaries. The course will refine skills already acquired in mathematics courses covering the topics listed.

IT SHOULD NOT BE TAKEN BY ANYONE JUST BEGINNING THE STUDY OF CALCULUS OR LINEAR ALGEBRA.

Topics:

real and complex numbers;
elementary set theory, including unions, intersections, and complements;
functions, equations and inequalities;
analytic geometry of two and three dimensions;
standard algebraic and transcendental functions;
limits, continuity, differentiability, and integrability;
derivatives, integrals, and partial derivatives;
the Fundamental Theorem of Calculus;
applications of derivatives and integrals, including multiple integrals;
finite and infinite sequences and series, including Taylor series;
the mean value theorem;
linear equations, vector spaces, generating sets;
bases and dimension;
subspaces;
scalar products;
linear transformations;
kernel and image space;
matrices;
determinants;
eigenvectors and eigenvalues.

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

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) the course is being structured in the hopes that it soon will be approved as the Third-Level Writing Course for math majors.

Texts:

A History of Mathematics - An Introduction, Victor J. Katz, is being used in 1994.

Others used in the past include:

An Introduction to the History of Mathematics, 4th edition, Howard Eves
A History of Mathematics, Carl B. Boyer
The Historical Development of Calculus, C. H. Edwards, Jr.

Sample Syllabus (from Sp 94, Katz text):

As taught Spring 1994, the class included problems assigned (and then covered in recitations) from most sections covered in the text, and also a term paper on a topic chosen by the student. In Sp 94 the class covered primarily Part Three of the Katz text (covering roughly 1400-1700) with some supplementary material on other periods.

Chapter 9	Algebra in the Renaissance	(4 lectures)
Chapter 10	Mathematical Models in the Renaissance	(4 lectures)

TEST 1

Chapter 11	Geometry, Algebra, and Probability in the Seventeenth Century	(3 lectures)

FIRST DRAFT OF TERM PAPER SUBMITTED AND RETURNED

Chapter 12	The Beginnings of Calculus	(5 lectures)

TEST 2 (middle of Chap. 12)

TERM PAPER DUE

For Further Information See:
Frank Carroll
1993-1994

Mathematics 507 **5 cr.** **Advanced Geometry**
A, W
(507N - Autumn quarter only)

Prerequisite:

Mathematics 152

Catalog Description:

Advanced topics from Euclidean Geometry.

Purpose of Course:

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

Text:

Euclidean & Non-Euclidean Geometries, Greenberg.

Topics:

1. Development of the axiom system underlying Euclidean geometry.
2. Investigation of the Euclidean, Hyperbolic and Elliptical parallel axioms.
3. Models of Hyperbolic Geometry

Course Coordinator:
Joe Ferrar
1993-1994

Mathematics 510.01 2-5 cr. Topics in Mathematics for Elementary School Teachers
510.02
510.03

Au, Wi, Sp, Su (listed this way in catalog)

NOT CURRENTLY OFFERED
THE LAST OFFERING OF ANY 510 WAS IN AU 91

Prerequisite:

One year teaching experience or permission of instructor.

Catalog Description:

Special topics in mathematics appropriate for teachers in the primary and intermediate grades. Repeatable to a maximum of 10 credit hours for each decimal subdivision with written permission of department.

Topics:

510.01 Geometry

510.02 Properties of Numbers

510.03 Numerical Methods

Audience

Designed for in-service teachers.

Course Coordinator:
Jim Schultz

Mathematics 512 **3 cr.** **Partial Differential Equations and Boundary Value Problems**
A, W, Sp, Su (1st Term)

Prerequisite:

Mathematics 255 or 415 or 556.

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:

Advanced Engineering Mathematics, 7th ed., Kreyszig

Syllabus: (Categories 1, 2, 3 MUST be covered)

1. Fourier Series: 8 days including a test.
Sections 10.1 - 10.5, 10.7. Optional: 10.6 and 10.7.

2. Partial Differential Equations: 8 days including a test.
Sections 11.1, 11.3-11.5. Only rectangular coordinates are considered. The text is a bit skimpy in the variety of examples and contexts in which separation of variables is used, especially with regard to Laplace's equation. It should be augmented somewhat.

3. Laplace Transform: 9 days including a test. Sections 6.1-6.8

4. Application of Laplace transform to PDE's (or other applications). Optional. 3 days. Section 11.13.

Course Coordinator:
Ted Scheick
1993-1994

Mathematics 513 **3 cr.** **Vector Analysis for Engineers**
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.

Texts:
There are three possibilities:

1) Introduction to Vector Analysis, Davis and Snider
2) Advanced Engineering Mathematics, Kreyszig
3) Div, Grad, Curl and All That, Schey; and Schaum's outline Vector Analysis

Syllabus:

Kreyszig: Chapters 8 and 9.
This text is too terse and must be augmented slightly. (e.g. see Schaum's Outline)

Davis and Snider:
This book is too verbose, and some selectivity will be required. But it has many extra ideas and good descriptions of the meanings of the quantities studied.

Chapter 1: 3 days
Review vector algebra, geometry, dot and cross products, lines and planes.
Sections 1-12, 14.

Chapter 2. 5 days
Vector functions of one variable, arc length, velocity acceleration, curvature.
Sections 1-3 (4 optional).

Chapter 3. 3 days
Vector and scalar functions. Chain Rule. Divergence, Gradient and Curl. Directional Derivative, normals and tangent planes.
Sections 1, 3-6.

Chapter 4. 15 days
Line integrals, potentials, surfaces, surface integrals. Green's Theorem, the Divergence Theorem and Stokes's Theorem. Potentials. Applications.
Sections 1-4, 8-12, 15, 16.

Course Coordinator:
Ted Scheick
1993-1994

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, or
Advanced Engineering Math, Kreyszig, 7th 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. These students want the text for reference and the lectures to make the text understandable.

Sample Syllabus #1 Based on Churchill: Days

1. Complex numbers, polar form	3
2. Analyticity, Cauchy-Riemann equations	3
3. Elementary functions	4
TEST	
4. Mapping by elementary functions	3
5. Cauchy integral theorem and consequences	5
TEST	
6. Power series	3
7. Residues, definite integrals	6

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

1. Complex analytic functions	9
2. Complex integrals	5
3. Power Series, Taylor and Laurent Series	4
4. Integration by residues	6
5. Conformal Mapping (omit 16.5)	4

6. Complex functions and potential theory: only if you have some time left over and the students are well-versed with the above material.

Course Coordinator:
Frank Carroll
1993-1994

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

Prerequisite:

H520 H 263 with a grade of C or better or H 264 with a grade of C or better, or written permission of Honors Committee chairperson. Not open to students with credit for H290.

H521 H 520 with a grade of C or better or written permission of Honors Committee chairperson. Not open to students with credit for H291

H522 H 521 with a grade of C or better or written permission of Honors Committee chairperson. Not open to students with credit for H292

Catalog Description For H520:

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

Catalog Description For 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.

Catalog Description For H522:

Analytic functions, Cauchy integral theory, residue calculus, series representations, conformal mapping. The sequence H520-H521-H522 substitutes for 568 and 569; 255 or 415; 416 or 514 or 552

Purpose of Course:

This three quarter sequence comprises the second year of the honors program in mathematics. It is designed to challenge talented, highly motivated students, regardless of their chosen major area of study. This sequence substitutes for Math 568 and 569, Math 255, 256, or 415, and Math 552. It is taught by faculty members in small sections with considerable teacher-student interaction.

Texts vary, for example:

Strang, Linear Algebra and Its Applications
Simmons, Differential Equations with Applications and Historical Notes
Marsden and Hoffman, Basic Complex Analysis, 2nd Edition

Course Coordinator:
Yung-Chen Lu (Honors)
1993-1994

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

Prerequisite:

Mathematics 254. Not open to students with credit for Statistics 520.

Catalog Description:

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

Purpose of Course:

To involve the student with the foundations of modern probability theory, and in the process, to strengthen his/her understanding of mathematical analysis by its use in probability theory.

Follow-up Course

Math 531

Text:

Probability, Jim Pitman.

Topics:

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

Course Coordinator:
Neil Falkner
1993-1994

Mathematics 531 **3 cr.** **Probability II**

NOT CURRENTLY OFFERED-Course removed from catalog Wi 91

Prerequisite:

Mathematics 530 or Statistics 520

Catalog Description:

Markov chains, classification of states and chains, stationary distributions, random walks, simple stochastic processes, Poisson process, birth and death processes, applications to genetics, diffusion, and queuing theory.

Purpose of Course:

To deepen and broaden the student's probability expertise through work in the specific areas of Markov chains and simple stochastic processes.

Follow-up Course:

Before taking further probability theory, a student will need Math 651-653.

Text:

A new text will be chosen if the course is ever re-offered.

Topics:

Further limit theorems, Markov chains and other stochastic processes. Additional topics.

THE COURSE HAS NOT RUN FOR THE PAST FIVE YEARS.

For Further Information See:
Neil Falkner

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

*** OFFERED IN ODD YEARS ONLY (Wi 1991, Wi 1993, Wi 1995)**

Prerequisite

Mathematics H290, or H263 and 569, or permission of the instructor

Catalog Description

Introduction to convex sets in E^n, some point set topology in E^n, (including compactness and connectedness properties of subsets of E^n), differentiation of vector valued functions of several variables, relative extrema, the inverse and implicit function theorems, and an introduction to Lebesgue integration in E^n.

Purpose of Course

The sequence H540, H541 is meant to provide an introduction the geometry and/or topology of n-dimensional Euclidean space E^n in a context that makes it relevant to the students' other studies. The sequence is meant to be conducted in a mathematically rigorous manner and will therefore provide more exposure for the students to precise mathematical definitions and proofs.

Follow-up course

Math H541.

Text

Wendell Fleming, Functions of Several Variables, Springer-Verlag, 1977.

(or similar level text)

Course Coordinator:
Yung-Chen Lu (Honors)
1993-1994

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

*** OFFERED IN ODD YEARS ONLY (Sp 1991, Sp 1993, Sp 1995)**

Prerequisite

Mathematics 540, or permission of the instructor

Catalog Description

Review and completion of the discussion of Lebesgue integration in E^n, coverage of change of variables theorems in E^n, differentiation of parametrized integrals, curves in E^n, differential 1-forms, line integrals, the exterior algebra and differential calculus in E^n, differential forms and tensor algebra, integration on manifolds, the divergence theorem, and Stokes' theorem.

Purpose of Course

The sequence H540, H541 is meant to provide an introduction the geometry and/or topology of n-dimensional Euclidean space E^n in a context that makes it relevant to the students' other studies. The sequence is meant to be conducted in a mathematically rigorous manner and will therefore provide more exposure for the students to precise mathematical definitions and proofs.

Text

Wendell Fleming, Functions of Several Variables, Springer-Verlag, 1977.

(or similar level text)

Course Coordinator:
Yung-Chen Lu (Honors)
1993-1994

Mathematics 547 **3 cr.** **Introductory Analysis I**
A, W

Prerequisite:

Mathematics 345.

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.

Follow-up Course:

Math 548.

Text:

Bartle, Introduction to Real Analysis (used 92-93, 93-94)
K. G. Binmore, Mathematical Analysis, 2nd Edition
W. Fulks, Advanced Calculus

Topics:

1. Binomial coefficients and binomial formula. Sum of geometric progression. Polynomials-order of a zero and factorization.

2. Inequalities and operations with inequalities. Monotone functions, monotone sequences.

3. Boundedness. Finding an upper and a lower bound for a given sequence or for a rational function on an interval. Other types of elementary estimates.

4. Definition of the limit. Limit rules. Standard examples of the limit.

5. Subsequences. Connection between the limit of a function and convergent sequences (without proof).

6. Definition of continuity. Properties of continuous functions (without proof).

Course Coordinator:
Bogdan Baishanski
1993-94

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:

Bartle, Introduction to Real Analysis (used 92-93, 93-94)
K. G. Binmore, Mathematical Analysis, 2nd Edition
I. Hirschman, Infinite Series
W. Fulks, Advanced Calculus

Topics:

1. Definition of the derivative. Differentiation rules.

2. Mean Value Theorem and its consequences.

3. Definition of the Riemann integral. A piecewise continuous function is Riemann integrable (without proof). Properties of the integral.

4. Fundamental Theorem of Calculus. Integration by parts and change of variable.

5. Taylor's formula for remainder in both integral and asymptotic form, i.e. as $o[(x-a)^n]$.

6. Exponential and logarithmic function.

7. Improper integrals.

Course Coordinator:
Bogdan Baishanski
1993-94

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

Prerequisite:

Mathematics 548.

Catalog Description:

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

Purpose of Course:

547, 548, 549 is a sequence designed to develop analytic intuition and proof skills. Student participation is emphasized. 549 is a continuation of 548. After completion of 548 the student is ready to begin the study of the calculus of several variables.

Text:

Bartle, Introduction to Real Analysis (used 92-93, 93-94)
K. G. Binmore, Mathematical Analysis, 2nd Edition
I. Hirschman, Infinite Series
W. Fulks, Advanced Calculus

Topics:

1. Numerical series. Integral test. Comparison test.

2. Absolute convergence. Alternating series. Summation by parts.

3. Rearrangements. Double series.

4. Functional sequences and series.

5. Uniform convergence.

6. Power series and trigonometric series. Taylor series and Fourier series.

7. Proofs of basic theorems in analysis (theorems which have earlier been stated without proof, such as the properties of continuous functions and the Cauchy principle of convergence).

Course Coordinator:
Bogdan Baishanski
1993-94

Mathematics 551 **5 cr.** **Vector Analysis**
Au, 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 416 or 513.

Text:

Introduction to Vector Analysis, 6th Ed., Davis & Snider was used 1993-1994.

or

Vector Analysis, Schaum's Outline Series and
Div, Curl, Grad & All That, Schey (these two were used together in 1992-93)

Other references:
Advanced Calculus, 2nd ed., Wilfred Kaplan. (With supporting problems from Schaum's.)
Vector Calculus, 3rd Edition, Marsden and Tromba.

Topics:

Vector operations in three dimensions, vector operators, line integrals, surface integrals, volume integrals. The theorems of Green, Gauss, and Stokes. Applications.

Course Coordinator:
Monique Vuilleumier
1993-1994

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

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 or 416. Because the course has minimal prerequisites, the emphasis will be on problem solving techniques. This course is not open to students with credit for 416 or 514.

Text:

Fundamentals of Complex Analysis, Saff & Snider (used 92-93 and 93-94)

or
Complex Variables and Applications, Churchill and Brown, or
Advanced Engineering Mathematics, Kreyszig, or
any one of a dozen others

Topics:

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

Course Coordinator:
Monique Vuilleumier
1993-1994

Mathematics 556 **3 cr.** **Differential Equations I**
W

Prerequisite:

Mathematics 255, and prerequisite or concurrent 572.

Catalog Description:

Systems of linear, first-order differential equations, existence and uniqueness theorems, numerical methods, qualitative theory (phase plane analysis, linearization, stability, limit cycles),physical applications.

Purpose of Course:

To provide the student with the modern mathematical foundations of differential equations. Course Objectives: systems of linear, first-order Differential equations, existence and uniqueness theorems, qualitative theory (phase plane analysis, linearization, stability, limit cycles).

Text:

For 1994 these texts were used as references:
Ordinary Differential Equations and Stability Theory: An Introduction, Sanchez
An Introduction to Differential Equations and Their Applications, Campbell

Topics and Sample Syllabus:

Linear Systems of Differential Equations	(3 weeks)
Numerical Methods	(2 weeks)
Existence and Uniqueness	(1 week)
Qualitative Analysis of Nonlinear Equations in the Plane	(4 weeks)

Grading: three midterms (100 pts. each) and final exam (200 pts.).

Course Coordinator:
David Terman
1993-1994

Mathematics 557 **3 cr.** **Differential Equations II**
Sp

Prerequisite:

Mathematics 556

Catalog Description:

Sturm - Liouville theory, partial differential equations in three or more variables, nonhomogeneous problems, Green's functions, and physical applications.

Purpose of Course:

An introduction to the basic properties of PDE's and to the techniques for analyzing them. Course Objectives: Basic properties of PDE's, wave equations, diffusion equations, Laplace's equations, Fourier series, and boundary value problems.

Possible Text:

Partial Differential Equations: An Introduction, W.A. Strauss, was used 1994.

Topics and Sample Syllabus:

Chapter 1 Where PDE's come from
1.1-1.4, 2 weeks

Chapter 2 Waves & Diffusions
2.1-2.5, 2 weeks

Chapter 4 Boundary Problems
4.1-4.3, 2 weeks

Chapter 5 Fourier Series
5.1-5.4, 2 weeks

Chapter 6 Harmonic Functions
6.1-6.3, 2 weeks

Possible grading: midterms (2 x 100 pts.), quizzes (10 x 10 pts.), final (200 pts.)

Course Coordinator:
David Terman
1993-1994

Mathematics 558 **3 cr.** **Differential Geometry of Curves and Surfaces**
Wi

NO LONGER OFFERED
LAST LISTED IN UNIVERSITY BULLETIN 1989-90.

Prerequisite:

Mathematics H292, or H522, or 568 and 547 or 551.

Catalog Description:

Introduction to the classical differential geometry of curves and surfaces, both in its local and global aspects.

Purpose of Course:

To provide a senior year option for honors students and simultaneously a differential geometry course below the 800 level for students of mathematics, science, and engineering.

Text:

Differential Geometry of Curves and Surfaces, Manfredo P. de Carmo

Topics:

I. Curves (2 weeks)

A. Parametrized curves
B. Regular curves; arc length
C. The vector product
D. The parametrization by arc length
E. Global properties of plane curves

II. Surfaces (3 weeks)

A. Regular surface
B. Inverse images of regular values
C. Change of parameters and differentiable functions on surfaces
D. The tangent plane, the differential of a map
E. The First Fundamental Form; Area

III. The Gauss normal map (2 weeks)

A. Definition and basic properties
B. The Gauss map in local coordinates
C. Ruled surfaces

IV. Intrinsic geometric properties (3 weeks)

A. Isometrics; conformal maps
B. Theorema Egreuium
C. Parallel transport; geodesics
D. The Gauss-Bonnet theorem and applications

Course Coordinator:
No Longer Offered

Mathematics 560 **4 cr.** **Point-set Topology**
Sp

Prerequisite:

Mathematics 345.

Catalog Description:

Sets and functions, metric spaces, topological spaces, subspaces, limits, closure, interior, sequences, convergence, separate axioms, continuity, connectedness, compactness, product spaces, Euclidean spaces.

Purpose of Course:

Math 560 offers an introduction to topological concepts. Students are asked for elementary proofs, although prior experience with proofs is not expected.

Follow-up Course:

Before taking further Topology courses, a student will need Math 547-548. Math 560 has significant overlap with Math 640. Math 655, 656, 657 is the follow-up sequence for students who have had or take concurrently Math 651, 652, 653.

Text:

Undergraduate Topology, Kasriel, or

Topology, Eisenberg

(or an equivalent text approved by the Course Coordinator)

Sample Syllabus:

Preliminaries	1 1/3 weeks
Metric spaces	2/3 week
Open and closed sets	2/3 week
Convergence and continuity	2/3 week
Product spaces	1/3 week
Special properties including completeness, separable, second countable	2 weeks
Compactness	1 1/3 weeks
Connectedness	1 week
Homeomorphisms and topological properties	1 week
Quotient spaces (optional)	

There should be two midterms (worth 100 points each) and one final examination (worth 200 points). Homework is a very important part of this course and therefore should be worth 150 points.

Course Coordinator:
Yung-Chen Lu
1993-1994

Mathematics 566 **3 cr.** **Discrete Mathematical Structures II**

A, W, Sp, Su (2nd Term)

Prerequisite:

Mathematics 366. Not open to students with credit for 576.

Catalog Description:

Algorithms, efficiency of algorithms; pigeonhole principle, combinatorial identities, inclusion-exclusion, general 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 CIS faculty is that it present math in rigorous form and require students to deal with abstract systems and mathematical proofs.

Text:

Discrete Mathematics and its Applications, Rosen.

Topics:

Chapter 1 Logic, Sets and Functions

- 1.8 The Growth of Functions

Chapter 2 Algorithms, the Integers and Matrices

- 2.1 Algorithms
- 2.2 Complexity of Algorithms
- 2.3 The Integers and Division
- 2.4 Integers and Algorithms
- 2.5 Applications of Number Theory

Chapter 3 Mathematical Reasoning

- 3.4 Recursive Algorithms

Chapter 5 Advanced Counting Techniques

- 5.1 Recurrence Relations
- 5.2 Solving Recurrence Relations
- 5.4 Inclusion-Exclusion
- 5.5 Applications of Inclusion-Exclusion
- A.3 Generating Functions

Chapter 7 Graphs

- 7.1 Introduction to Graphs
- 7.2 Graph Terminology
- 7.3 Representing Graphs & Graph Isomorphism
- 7.4 Connectivity
- 7.5 Euler and Hamiltonian Paths
- 7.6 Shortest Path Problems
- 7.7 Planar Graphs
- 7.8 Graph Coloring

Chapter 8 Trees

- 8.1 Introduction to Trees
- 8.5 Spanning Trees
- 8.6 Minimal Spanning Trees

Course Coordinator:
Tom Dowling
1993-1994

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

Prerequisite:

Mathematics 254. Not open to students with credit for 471, 571 or 577.

Catalog Description:

The space $\mathbb{R}^n$ and its subspaces; matrices as mappings; matrix algebra; systems of equations; determinants; dot product in $\mathbb{R}^n$; geometric interpretations.

Purpose of Course:

The purpose of the course is to provide an introduction to the concepts, vocabulary, notation and results of matrix algebra with interpretations in the space $\mathbb{R}^n$. Emphasis is on techniques, computational skills, and development as algebraic structure.

Follow-up Course:

Math 569.

Text:

Introduction to Linear Algebra, Johnson, Riess, and Arnold, 3rd edition. (The 3rd edition was first used Sp 93 in 568, replacing the 2nd edition; Schneider was used 1991-92 but Johnson & Riess 2nd edition replaced it Autumn 1992.)

Topics and Sample Syllabus:

Chapter 1 Matrices and Systems of Linear Equations: Intro. & Gaussian Elimination (1.1), Solution Sets for Linear Systems (1.2), Matrices and Echelon Form (1.3), Consistent Systems of Linear Equations (1.4), Matrix Operations (1.6), Algebraic Operations of Matrix Operations (1.7), Linear Independence and Nonsingular Matrices (1.8), Matrix Inverses and Their Properties (1.10), Finding the Inverse of a Nonsingular Matrix (1.11)

Review and Midterm #1

Chapter 2 The Vector Space $\mathbb{R}^n$: Intro (2.1), Vector Space Properties (2.2), Examples of Subspaces (2.3), Bases for Subspaces (2.4), Dimension (2.5), Orthogonal Bases for Subspaces (2.6), Linear Transformations from $\mathbb{R}^n$ to $\mathbb{R}^m$ (2.7), The Least Squares Problem in $\mathbb{R}^n$ (2.8), Fitting Data and Least-Squares Solutions (2.9).

Chapter 3 The Eigenvalue Problem: Intro (3.1), Determinants and the Eigenvalue Problem (3.2)

Review and Midterm #2

Elementary Operations and Determinants (3.3), Eigenvalues and the Characteristic Polynomial (3.4), Eigenvectors and Eigenspaces (3.5), Complex Eigenvalues and Eigenvectors (3.6).

Review and Final Exam

Course Coordinator:
Dan Shapiro
1993-1994

Mathematics 569 **3 cr.** **Introductory Linear Algebra II**
A, W, Sp, Su (2nd Term)

Prerequisites:

Mathematics 568. Not open to students with credit for 572 or 577.

Catalog Description:

Vector spaces over $\mathbb{R}$ and $\mathbb{C}$; linear transformations; the polynomial ring $\mathbb{R}[x]$; characteristic values and vectors; inner product spaces; quadratic form reduction; principal axis theorem.

Purpose of Course:

The purpose of the course is to provide an introduction to vector spaces as an algebraic structure. Relying on the techniques and interpretations established in 568, more emphasis is placed here on abstraction and proof.

Text:

Introduction to Linear Algebra, Johnson, Riess and Arnold, 3rd edition. (Was first used in 569 for Summer 1993, replacing the 2nd edition which was used through Spring 93 in 569.)

Topics:

1. Definitions and examples of vector spaces over $\mathbb{R}$ and $\mathbb{C}$ (include $M_{m,n}(\mathbb{R})$ and function spaces).
2. Definition of linear transformations; kernel, image, isomorphisms; dimension relations.
3. Symmetric matrices; inner products and quadratic forms.
4. Principal Axis Theorem (least squares and spectral theory).

For the service aspects of the course (statistics, physics, engineering), the latter two topics are of importance. A fairly thorough treatment of these should be included. If time permits, one could treat canonical forms.

Course Coordinator:
Dan Shapiro
1993-1994

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

Prerequisite:

Math 254. Not open to students with credit for 569 or 601.

Catalog Description:

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

Text:

1. Experiments in Computational Matrix Algebra, David R. Hill

2. Linear Algebra with Applications, S. Leon

Topics List:

The course combines theoretical linear algebra (Leon) with hands-on experience (Hill, and the software package Matlab). Most or all classes will be held in a Macintosh Lab. Chapters 1-3 and the first half of each of chapters 4 and 5 will be covered from Leon, as well as chapters 1 and 2 of Hill. No programming is required for this course.

Leon:

Chapter 1-Matrices and Systems of Equations
Chapter 2-Determinants
Chapter 3-Vector Spaces
Chapter 4-Linear Transformations (beginning)
Chapter 5-Orthogonality (Sections 5.1 to 5.5)

Hill:

Chapter 1-Beginning to use MATLAB
Chapter 2-Linear Systems of Equations

Course Coordinator:
Ed Overman
1993-1994

Mathematics 572 **3 cr.** **Linear Algebra for**
A, Sp, 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:

1. Experiments in Computational Matrix Algebra, David R. Hill

2. Linear Algebra with Applications, S. Leon

Topics List:

This is a continuation of 571. Chapters 4 and 5 of Leon's book will be completed, and Chapter 6 covered. Chapter 3 of Hill will be covered. There will be additional selected applications from Hill.

Leon:
- Chapter 4 - Linear Transformations
- Chapter 5 - Orthogonality (Sections 5.6-end of chapter)
- Chapter 6 - Eigenvalues

Hill:
- Chapter 3 - Eigenvalues and Eigenvectors

Course Coordinator:
Ed Overman
1993-1994

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

Prerequisite:

Mathematics 153

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 $\mathbb{Z}$; 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. Extensions and generalizations: polynomial rings over fields; quadratic number fields.

Course Coordinator:
Paul Ponomarev
1993-94

Mathematics 574 **5 cr.** **Geometry**
Sp of even numbered years

Prerequisite:

Mathematics 568.

Catalog Description:

Euclidean and non-Euclidean geometry, emphasizing algebraic connection; Affine and projective planes, duality. Topics from: geometry of groups; finite planes, Hilbert's postulates, n-dimensional spaces.

(NOTE: The "Topics from" part of the catalog description is misleading. See below for the emphasis of the course.)

Purpose of Course:

To strengthen geometric intuition, stress geometric aspects of linear algebra, and to introduce the student to geometries different from high school geometry. Kaplansky's little book, Linear Algebra and Geometry; A Second Course, conveys the ideal spirit one should try to achieve.

Topics:

Construction of the real projective plane from the affine plane, barycentric and homogeneous coordinates, duality, affine and projective transformations, double ratio. Conic sections, and the group of a conic section. Exercises on projective planes over $\mathbb{Z}$ mod p.

Course Coordinator:
Joe Ferrar
1993-1994

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

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 non-algebraic mathematical problems. The primary emphasis is on theory, but numerous illustrations and applications are presented. In addition, much of the theory (e.g., network flow theory, matching 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:

Combinatorics: An Invitation, Straight

Topics List:

1. Basic counting principles: sets, mappings, one-to-one correspondences and cardinality, the rules of sum and product, pigeonhole principle, binomial coefficients.

2. Enumeration theory: inclusion - exclusion principle, recurrence relations, generating functions.

3. Elementary graph theory: paths, connectivity, Eulerian and Hamiltonian graphs, matchings in bipartite graphs, planar graphs, graph colorings.

4. Combinatorial designs: Latin squares, finite geometries, block designs, difference sets.

Course Coordinator:
Tom Dowling
1993-1994

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

Prerequisite:

CIS 221, and Mathematics 568, and either Mathematics 530 or Statistics 425.

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

Applications of Linear Algebra, Anton and Rorres

An Introduction to Mathematical Models, Olinick

A variety of different modules available through COMAP

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.

Course Coordinator:
Tom Ralley
1993-1994

Mathematics 580	**3 cr. each**	**Algebra I**
581		**Algebra II**
582		**Algebra III**

580: A, W
581: W, Sp
582: Sp, A

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:

This sequence permits students to study topics of number theory, linear algebra, and algebraic structures in a unified and integrated way.

See the reverse side for quarter-by-quarter topics lists. When there are two or more sections, instructors are asked to coordinate the content between sections. Instructors are also urged to put heavy emphasis on problem solving.

Text:

A Book of Abstract Algebra, Pinter. (used 1993-4)

or

Abstract Algebra, Hungerford (used 1992-93)

or

Abstract Algebra, Herstein, or Paley and Weichsel; or McCoy.

(Over for Topics)

Topics List

Math 580 Topics:
Elementary properties of groups, groups of permutations, isomorphism, cyclic groups, Lagrange's Theorem, homomorphisms.

The material covered in Chapters 1-15 of Pinter's book is the core. Additional topics will be selected by the instructor.

Math 581 Topics:
The Fundamental Homomorphism Theorem for Groups, elementary properties of rings, integral domains, factorization into primes, elementary properties of integers, rings of polynomials.

The material covered in Chapters 16-26 of Pinter's book is the core. Additional topics will be selected by the instructor.

Math 582 Topics:
Vector spaces, extensions of fields, rulers and compass, Galois theory, solving equations by radicals.

The material covered in Chapters 27-33 of Pinter's book is the core. Additional topics, such as finite fields, quadratic number fields, inner products, orthogonal transformations, from field theory and/or linear algebra will be selected by the instructor.

Course Coordinator:
Manohar Madan
1993-94

Mathematics	**H590**	**Au**	**5 cr.**	**Algebraic Structures I**
	H591	**Wi**	**3 cr.**	**Algebraic Structures II**
	H592	**Sp**	**3 cr.**	**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 For H590:

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:

Topics in Algebra, Herstein

Suggested Topics List

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.

For Further Information see:
Yung-Chen Lu (Honors)
1993-1994

Mathematics 601 **5 cr.** **Mathematical Methods in Science I**

Au

Prerequisite:

Fifteen quarters of mathematics at the 400-500 level or permission of the department. The recommended preliminary courses are 514 and either 513 or 551.

Catalog Description:

Real and complex vector spaces, inner product spaces, linear operators, matrices, eigenvalue problems, normal operators, real and Hermitian forms, applications to physics and engineering.

Purpose of Course:

After this course the students should be able to do all of the 601 questions on the past 5 years of the general exams for engineers and scientists on file in the library.

Many examples are given, using function spaces and complex and real n-space. This is primarily a course in finite dimensional vector spaces.

This is a skills course; the students should do many problems.

Follow-up Courses:

Math 602 and then 701.

Texts:

No one text is yet satisfactory. References include Hoffman & Kunze, Gelfand, Smirnov, Butkov, Stackgold, Hildebrand & Friedman.

(Over for Topics)

Topics List

1. Real and complex vector spaces, subspaces, linear independence, basis, dimension. Change of basis. Review of solutions of linear (matrix) equations, determinants and matrix inverses.

2. Linear operators, matrix of an operator, change of basis, rank and nullity theorem.

3. Inner product spaces, orthogonal sets, Gram-Schmidt process and the Gram matrix. Examples with weighted inner products in function spaces and in complex n-space. Projection and best approximation in the L^2 norm. Examples include overdetermined systems, curve fitting, finite orthogonal (Fourier) expansions, etc. Unitary change of basis, orthogonal complement of a subspace. Examples and applications.

4. Eigenvalues and eigenvectors. Diagonalization of operators. Functions of diagonalizable operators. Application to linear systems of differential equations.

5. Adjoint of an operator with examples in finite and infinite dimensional spaces. Matrix of the adjoint. Normal, Hermitian and unitary operators. Spectral theorem and converse (orthogonal diagonalization of normal operators). Rayleigh quotient and approximation of eigenvectors and eigenvalues (power method). Many examples.

6. Quadratic forms, principal axis theorem (orthonormal diagonalization of a Hermitian form), other methods of diagonalization, Sylvester's theorem, simultaneous diagonalization of quadratic forms.

7. Applications to the theory of small oscillations. Small oscillations with damping, simultaneous diagonalization of commuting Hermitian operators.

The material need not be done in exactly this order.

Pacing:		
	1-2	15 days
	3-4	12 days
	5	10 days
	6-7	13 days

For Further Information See:
Ted Scheick
1993-1994

Mathematics 602 **5 cr.** **Mathematical Methods in Science II**

Wi

Prerequisite:

Mathematics 601

Catalog Description:

Linear differential equations, solutions about singular points; Sturm-Liouville problems; Bessel functions, Legendre functions; Green's functions; orthogonal expansions; Laplace's equation and boundary value problems.

Purpose of Course:

After 602, the students should be able to do all of the 602 problems on the past 5 years of the general exams for engineers and scientists on file in the library.

Many examples are done. The students should do many problems. This is a skills course.

Follow-up Courses:

Mathematics 701.

Text:

No one text is entirely suitable. References include Stackgold, Friedman, Lebedev, Budak & Samarski & Tikhonov, Duff & Naylor, Byron & Fuller, Butkov, Denneryl & Krzywicki, Zaudever.

(Over for Topics)

Topics List

1. Introduction to Hilbert spaces, norm convergence. complete orthogonal sets. Bessel's inequality and Parseval's identity.

2. Sturm-Liouville operators and the associated weight function, boundary conditions yielding a Hermitian operator, Green's identities. Eigenvalue problems, a-priori estimates of eigenvalues. Orthogonality and completeness of the eigenfunctions. Green's functions for Sturm-Liouville operators, series and closed forms.

3. Boundary conditions making the Laplace operator Hermitian. Green's functions for the Laplacian and related operators (mainly in 2 space dimensions), the eigenvalue problem for these operators. Do more examples in 4, 5.

4. Bessel functions, recursions, identities, generating function, orthogonality, completeness. Many examples using separation of variables on the standard PDE's of physics and engineering.

5. Legendre polynomials recursions, identities, generating function, orthogonality, completeness. Associated Legendre functions (first kind only). Laplace operator in spherical coordinates. Expansions in spherical harmonics. Poisson's formula. Eigenvalues and eigenfunctions of the Laplacian acting on spaces of functions satisfying certain boundary conditions on a sphere. Solve several of the classical PDE's via spherical harmonics by separation of variables.

Remark: One may wish to do the special functions first, and then go into the techniques of separation of variables, orthogonal expansions, and Green's functions with more examples than possible. One should treat non-homogeneous equations to some extent. It is useful to tie things together often with the ideas of 'Hermitian operator', 'eigenvalue problem', and 'expansion via a complete orthogonal set' as unifying themes. Green's functions are best approached using the delta function. Examples should be done in Cartesian, polar, cylindrical and spherical coordinates.

Pacing:
1. 4 days
2. 14 days
3. 6 days
4. 12 days
5. 14 days

For Further Information See:
Ted Scheick
1993-1994

Mathematics 616 **4 cr.** **Numerical Methods in**
Au (2 2-hour classes) **Actuarial Mathematics**

Prerequisite:

Mathematics 254, and either 471 or 569; or permission of instructor.

Catalog Description:

Finite differences, difference operators, interpolation, summation, difference equations; applications to actuarial science and finance.

Purpose of Course:

This course is designed to provide students with an introduction to the mathematical topics in numerical analysis which are relevant to actuarial science. The course includes the material on numerical methods in the Associateship Examination of the Society of Actuaries and the Casualty Actuarial Society. The course is required for the undergraduate major in actuarial science.

Text:

Numerical Analysis., Burden, R. L., Faires, J. D., 4th edition, 1989, PWS Publishers.

Topics:

The minimum course content is:

1. Solution of Equations in One Variable
2. Interpolation and Polynomial Approximation
3. Numerical Integration
4. Direct Methods for Solving Linear Systems
5. Discrete Least-Squares Approximation

For further information see:
Robert Brown
1993-1994

Mathematics 618 **3 cr.** **Theory of Interest**
Wi (Two 1 1/4-hour classes)

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:

This course is the first with any specific actuarial content. 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 the associateship examinations of the various actuarial organizations. The course is required for the undergraduate major in actuarial science.

Text:

The Theory of Interest, 2nd edition, S. G. Kellison.

Mathematics of Compound Interest, M. V. Butcher and C. J. Nesbitt, is a useful reference.

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.

For further information see:
Robert Brown
1993-1994

Mathematics 630 — **3 cr.** — **Mathematics of Life Contingencies I**
631 — **Mathematics of Life Contingencies II**
632 — **Mathematics of Life Contingencies III**

Au: 630 (Two 1 1/4 hour classes)
Wi: 631 (Two 1 1/4 hour classes)
Sp: 632 (Two 1 1/4-hour classes)

Prerequisite:

Mathematics 618, and 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: Continuation of 631; valuation theory for pension plans; insurance models including expenses; nonforfeiture benefits and dividends; topics of interest in life and casualty contingencies.

Purpose of Course:

This course is designed to introduce students to the mathematical content of the theory of contingencies. The course includes the material on life contingencies in the Associateship Examination 150 of the Society of Actuaries. The course is required for the undergraduate major in actuarial science.

Text:

Actuarial Mathematics., Newton L. Bowers, Jr., et al, Society of Actuaries, 1986.

The following are useful references:

Life Contingencies, C. W. Jordan
Mortality Table Construction, R. W. Batten

(Over for Topics)

Topics List

Minimum Course Content:

630
1. Survival Distributions and Life Tables
2. Life Insurance and Life Annuities
3. Net Premiums

631
4. Net Premium Reserves
5. Multiple Life Functions
6. Multiple Decrement Models
7. Valuation Theory for Pension Plans

632
8. Insurance Models including Expenses
9. Nonforfeiture Benefits and Dividends

Special Note:

The minimum course content should be completed by May 1 for the benefit of students preparing for the May actuarial examinations.

For further information see:
Robert Brown
1993-1994

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

Prerequisite: Mathematics 547 or permission of the Graduate Advising Comm.

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. The plan of the course is to work on topics close to application in statistics, and to use feedback from student discussion, board presentations, and exercise sets to determine what advanced calculus material needs special review.

Text: Principles of Mathematical Analysis, (3rd.), by Walter Rudin, McGraw-Hill.

Topics:

Week 1: Completeness, countability, Cantor set, introduction to the Riemann-Stieltjes integral.

Week 2: Existence and properties of the Riemann-Stieltjes integral.

Week 3: Integration of vector-valued functions, rectifiable curves. Examples illustrating difficulties in interchange of limit processes; uniform convergence. Test 1.

Week 4: Uniform convergence of sequences of complex valued functions, as related to continuity, integration and differentiation.

Week 5: Discussion of exercises; review of advanced calculus topics, especially continuity. Test 2.

Week 6: Power series: analytic properties, radius of convergence, including review of less advanced topics.

Week 7: Exponential, logarithmic and trigonometric functions; the gamma function.

Week 8: Complex Fourier series.

Week 9: Discussion of exercises.

Week 10: Review and final examination.

The students' grades will be based on the two tests (20% each), the final examination (40%), exercise sets (20%).

For Further Information See:
Frank Carroll
1993-1994

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, Statistics Ph.D. students, Mathematics Ph.D. students with incomplete prerequisites, and a few others. General work on writing proofs, and on analytic intuition. These courses are the preparation 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 Text:

K. Stromberg, An Introduction to Classical Real Analysis (used 93-94)
651: Chapters 2 and 3
652: Chapters 4, 5 and 7 (except optional sections).
653: Chapter 6

or:

W. Rudin, Principles of Mathematical Analysis and H. Royden, Real Analysis
651: Rudin, Chapters 1-5
652: Rudin, Chapters 6-8
653: Rudin, Chapter 9, and Royden, parts of Chapters 3, 4, 11 and 12

or:

K. Hoffman, Analysis in Euclidean Space
651: Chapters 2 and 3
652: Chapters 4 and 5 (and possibly 6)
653: Chapters 7 and 8

or: equivalent text chosen by the instructor--If another text is chosen, be sure to cover the Qualifying Exam syllabi-the M.S. syllabus in the first two quarters, and the Ph.D. syllabus in the three quarters.

For Further Information see:
Gerald Edgar
1993-1994

Mathematics	**670**	**Au**	**5 cr.**	**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.

Catalog Descriptions (as currently appearing in Univ. Bulletin):

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

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

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

(NOTE: These descriptions do not reflect accurately the current content of the courses. The content does vary year-to-year depending on the instructor and text. SEE OTHER SIDE for a better list of topics as currently taught.)

Purpose of Course:

Standard entry for M.S. students in mathematics. Should supply much (but not necessarily all) of the material needed for the Qualifying Master's Examination in Algebra.

Text:

Algebra, Artin (used 1992-1993 and 1993-1994)
or
Topics in Algebra, Herstein.

(Over for Topics)

Topics List

(With Syllabus Followed 1993-94)

670: 1) Elementary Number Theory: gcd, congruence, Euler-Fermat theorem (3 weeks)

2) Basic Linear Algebra: vector spaces (especially finite-dimensional and function spaces), bases, change of basis; linear operators and their matrices, rank and nullity, determinants, eigenvalues and eigenvectors, minimal and characteristic polynomials and the Cayley-Hamilton Theorem; simultaneous diagonalization (5 weeks)

3) Basic Group Theory: elementary concepts: element order, cyclic groups, Lagrange's Theorem (2 weeks)

671: 1) Statement and proof of structure theorem on finitely generated abelian groups. (3 weeks)

2) Group Theory with emphasis on groups acting on sets, Sylow theorems (2 weeks)

3) Statement and proof of rational and Jordan canonical form. (3 weeks)

4) Basic Bilinear Algebra: Bilinear and hermitian forms, inner product spaces, Gram-Schmidt, orthogonal decompositions and projections (2 weeks)

672: 1) Basic commutative ring theory: rings (with 1), homomorphisms, ideals, principal ideals, prime and maximal ideals, quotient rings. PID's, UFD's. Ideals and quotients of k[x]. (4 weeks)

2) Galois Theory: Finite extensions of $\mathbb{Q}$, basic Galois correspondence. Finite fields. Solvability by radicals. Straight-edge and compass constructions. (6 weeks)

For Further Information See:
Joe Ferrar
1993-1994

Mathematics 701 **5 cr.** **Mathematical Methods**
Sp **In Science III**

Prerequisite:

Mathematics 601, or permission of department.

Catalog Description:

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

Purpose of Course:

After 701, the students must be able to do all of the 701 problems on the last 5 years of the general exams for engineers and scientists on file in the library. Many examples are done, and the students should do many problems.

Texts:

Weinstock, Gelfand & Fomin, Smith for calculus of variations.

Sokolnikoff for tensors. This is out of print; it is the correct level and is hard to replace.

Topics List

Calculus of Variations (about 5 weeks)

1. The first variation of a functional is computed for many kinds of functionals. The Euler-Lagrange equations are derived, along with various 'natural boundary conditions' for unconstrained ends. The students should know this method along with the formulae.

2. Lagrange multipliers for integral and pointwise constraints.

3. Transversality conditions.

4. Goedesics.

5. Hamilton's equations.

6. Rayleigh-Ritz method of approximating eigenvalues and eigenfunctions of Sturm-Liouville operators.

Tensor Analysis (about 5 weeks)

1. Definitions, examples, rough idea of 'manifold', algebraic laws, quotient theorem.

2. Metric Tensor, Christoffel symbols, covariant derivative intrinsic derivative. Classical differential operators in tensor notation. Examples on surfaces (first and second fundamental forms, curvatures), in 3 dimensional Euclidean spaces, and in 'space-time' for relativity theory.

3. Geodesics, Riemann-Christoffel tensor, Riemannian manifolds and Euclidean manifolds. Developable surfaces.

Do whatever applications you can. This is primarily intended to be an introduction to the language and skills of tensor analysis. Each department has it's own way of using tensors.

For Further Information See:
Ted Scheick
1993-1994