Department of Mathematics
The Ohio State University

2014-2015 Mathematics Courses

Course Number	Course Title
1050	Precollege Mathematics I
1075	Precollege Mathematics II
1116	Excursions in Mathematics
1118	Mathematics for Architects
1125	Mathematics for Elementary Teachers I
1126	Mathematics for Elementary Teachers II
1130	College Algebra for Business
1131	Calculus for Business
1148	College Algebra
1149	Trigonometry
1150	Pre-Calculus
1151	Calculus I
1152	Calculus II
1156	Calculus for the Biological Sciences
1157	Mathematical Modeling for the Biological Sciences
1161.01	Accelerated Calculus I
1161.02	Accelerated Calculus I for Honors Engineers
1165	Math for Middle School Teachers I
1166	Math for Middle School Teachers II
1172	Engineering Mathematics A
1181H	Honors Calculus I
1187H	Honors Problem Solving
1295#	Introductory Seminar
2153	Calculus III
2162.01	Accelerated Calculus II
2162.02	Accelerated Calculus II for Honors Engineers
2167	Calculus for Middle School Teachers
2168	History of Mathematics for Middle School Teachers
2173	Engineering Mathematics B
2174	Linear Algebra & Differ. Equations for Engineers
2177	Mathematical Topics for Engineers
2182H	Honors Calculus II
2255	Differential Equations and Their Applications

Course Number	Course Title
2366	Introduction to Discrete Mathematics
2415	Ordinary and Partial Differential Equations
2568	Linear Algebra
3345	Foundations of Higher Mathematics
3350	Introduction to Mathematical Biology
3532	Mathematical Foundations of Actuarial Science
3588	Practicum in Actuarial Science
3589	Introduction to Financial Mathematics
3607	Beginning Scientific Computing
3618	Theory of Interest
4181H	Honors Analysis I
4182H	Honors Analysis II
4350	Quantitative Neuroscience
4504	History of Mathematics
4507	Geometry
4512	Partial Differential Equations for Science & Eng.
4530	Probability
4545	Analysis Overview
4547	Introductory Analysis I
4548	Introductory Analysis II
4551	Vector Analysis
4552	Complex Analysis
4556	Dynamical Systems
4557	Partial Differential Equations
4568	Linear Algebra for Engineering Graduate Students
4573	Elementary Number Theory
4575	Combinatorial Mathematics
4578	Discrete Mathematical Models
4580	Abstract Algebra I
4581	Abstract Algebra II
5520H	Honors Linear Algebra and Differential Equations
5522H	Honors Complex Analysis
5529H	Honors Combinatorics
5530H	Honors Probability
5540H	Honors Differential Geometry
5576H	Honors Number Theory
5590H	Honors Abstract Algebra I
5591H	Honors Abstract Algebra II
5630	Life Contingencies I
5631	Life Contingencies II

Course Number	Course Title
5632	Financial Economics for Actuaries
5633	Loss Models I
5634	Loss Models II
5756	Mathematical Methods in Relativity Theory I
5757	Mathematical Methods in Relativity Theory II

Mathematics 1050 **5 credits** **Precollege Mathematics I**
Au, Sp

Catalog Description:
Fractions and decimals, basic algebra, graphing lines, factoring, systems of equations. Credit for this course will not count toward graduation in any degree program.

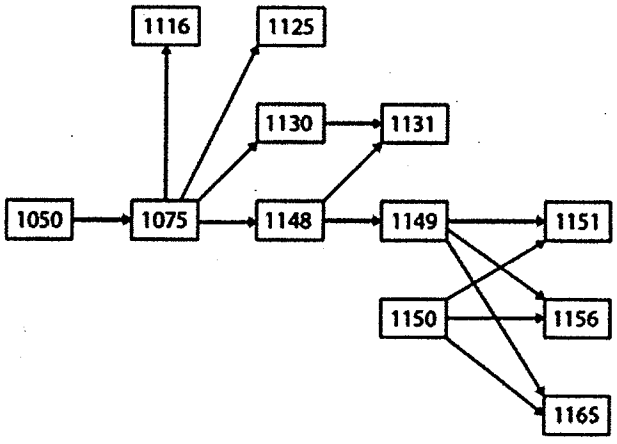
Prerequisite:
Math Placement Level T; or Math 1040 or 40 or 50; or permission of department.

Exclusions:
Not open to students with credit for any Math course above 1050 (050).

Purpose of Course:
Mathematics 1050 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 Math 1075.

Follow-up Course:
Math 1075

Sequencing Chart:



Mathematics 1050 **5 credits** **Precollege Mathematics I**
Au, Sp

Text:
Beginning Algebra, 8th edition, by Aufmann & Lockwood, Cengage, ISBN: 9781285101279

Topics List:

1. Review: real numbers, number line, integral exponents, scientific notation, negative numbers, fractions, order of operations, basic geometry.
2. Linear equations and inequalities in one variable. Applications: word problems.
3. Graphical representations, straight lines as graphs, slope, intercepts, slope-intercept form, and point-slope form. Linear inequalities in two variables.
4. Systems of two linear equations in two unknowns.
5. Polynomials: addition, subtraction, multiplication, factoring, division.
6. Solving quadratic equations by factoring. Applications.
7. Introduction to function notation.

Catalog Description:
Algebraic, rational, and radical expressions; functions and graphs; quadratic equations; absolute value; inequalities; and applications.

Prerequisite:
Math Placement Level S, a grade of C– or better in Math 1050, or credit for Math 75 or 1074.

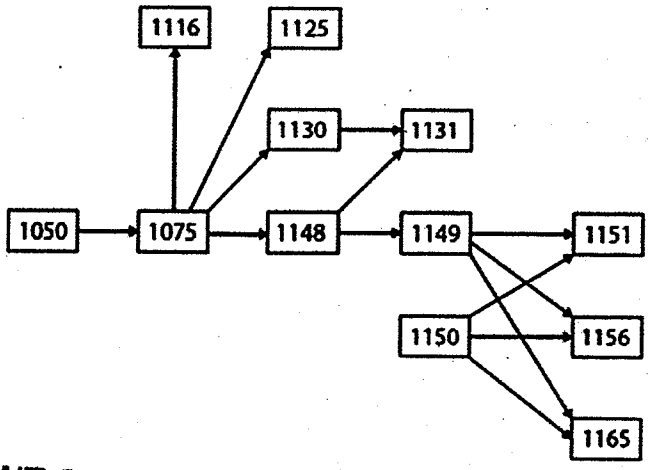
Exclusions:
Not open to students with credit for any higher numbered math class, or for any quarter math class numbered higher than 75.

Text:
Intermediate Algebra: Math 1075, OSU Custom Edition, Miller, O'Neill & Hyde, McGraw-Hill, ISBN 9781269577980

Follow-up Courses:

- Math 1116 for students in liberal arts or students in the precertification programs on regional campuses.
- Math 1125 for students intending to pursue a M.Ed. in early or middle childhood.
- Math 1130 College Algebra for Business
- Math 1148 Traditional College Algebra

Sequencing Chart:



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

Topics List:

Ch. 4 Linear Inequalities
- 4.1 Solving linear inequalities using addition & subtraction
- 4.2 Solving linear inequalities using multiplication & division
- 4.3 Solving compound inequalities
- 4.4 Solving absolute value equations & inequalities
- 4.5 Graphing systems of inequalities in two variables

Ch. 6 Factoring Polynomials
- 6.1 Introduction to factoring polynomials
- 6.2 Factoring trinomials of the form $x^2 + bx + c$
- 6.3 Factoring trinomials of the form $ax^2 + bx + c$
- 6.4 Factoring special binomials
- 6.5 Factoring by grouping; General strategies for factoring
- 6.6 Solving equations by factoring

Ch. 9 Rational Functions
- 9.1 Graphs of rational functions
- 9.2 Reducing rational expressions; Multiplying and dividing rational expressions
- 9.3 Adding and subtracting rational expressions
- 9.4 Combining operations; Complex rational expressions
- 9.5 Solving equations containing rational expressions
- 9.6 Inverse and joint variation; Other applications yielding equations with fractions

Ch. 7 Solving Quadratic Equations
- 7.1 Extraction of roots and properties of square roots
- 7.2 Solving quadratic equations by completing the square
- 7.3 The quadratic formula
- 7.4 Applications of quadratic equations
- 7.5 Complex numbers; Solving quadratic equations with complex solutions

Ch. 8 Functions: Linear, Absolute Value, and Quadratic
- 8.1 Functions and representations of functions
- 8.2 Linear Functions
- 8.3 Absolute value functions
- 8.4 Quadratic functions

Ch. 10 Square Root & Cube Root Functions and Rational Exponents
- 10.1 Evaluating radical expressions
- 10.2 Adding & subtracting radical expressions
- 10.3 Multiplying & dividing radical expressions
- 10.4 Solving equations containing radical expressions
- 10.5 Rational exponents & radicals

Mathematics 1116 **3 credits** **Excursions in Mathematics**
Au, Sp

Catalog Description:
Critical thinking and problem solving, with relevant topics met in everyday life. Appropriate for non-science majors.

Prerequisite:
Math Placement Level R or higher; or credit for 1075, 75, 104, 1073 or 1074;
or ACT math score ≥ 22 or SAT math score ≥ 520 (scores must be less than 2 years old).

Exclusions:
Not open to students with credit for Math 1152 or higher, or for quarter math class numbered 153 or higher.

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

Follow-up Courses:
None. Math 1116 is a terminal course.

Text:
Excursions in Modern Mathematics, 8th edition, by Tannenbaum, Pearson,
ISBN 9780321825735

Topics List:

1. Graph theory: graphs, Euler and Hamilton circuits, algorithms for Traveling Salesman Problem, spanning trees, etc.
2. Voting & apportionment: preference ballots; apportionment paradoxes; Congressional apportionment; methods of Jefferson, Adams, and Webster.
3. Patterns & growth: Fibonacci and recursive sequences, golden ratio, population growth models: linear, exponential, and logistic.
4. Symmetry: Rigid motions, rosettes, friezes, rudiments of group theory.
5. Counting & probability: counting principles, permutations and combinations, multiplication rule, randomness, probability.
6. Fractals: recursive definitions, standard examples (Koch snowflake, Sierpinski gasket etc.), self-similarity, fractional dimension.
7. Linear programming: mixture problems, examples in low dimension, corner point principle, algorithms.

Mathematics 1118 **3 credits** **Mathematics for Architects**
Au, Sp

Catalog Description:
Topics in geometry for architecture majors.

Prerequisite:
Enrollment in the School of Architecture and: Math Placement Level L or M; C- or better in 1148 or 1150; or credit for 148 or 150.

Purpose of Course:
The majority of the audience is made up of Architecture majors for whom the course is a requirement. The intent of the course is to introduce these students to the mathematics inherent in 2D and 3D design. Moreover, there is an emphasis on similar figures and the issues that arise when scaling lengths, areas, and volumes.

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 Advisors in 250 Mathematics Bldg.

Text:
Course Notes, by Snapp

Topics List:

1. Geometric models, transformations, matrices.
2. Plane tessellations, concepts of symmetry.
3. Polyhedra: Platonic and Archimedean.
4. Invariants: area, volume, Euler characteristic.
5. Mathematics of perspective drawing.
6. String art: curves defined as envelopes of tangent lines, ruled surfaces.
7. Discrete curvature: Descartes theorem and beyond.
8. Higher dimensions: tesseracts and other 4-D polyhedra.

Mathematics 1125 **5 credits** **Mathematics for**
Au, Sp **Elementary Teachers I**
**Currently taught in either lecture/recitation or workshop format.*

Catalog Description:
Math 1125 involves numbers, operations, geometry, measurement, and mathematical reasoning for prospective elementary school teachers.

Prerequisite:
A grade of C- or above in 1075; or credit for 1074, 75, or 104; or Math Placement Level R or above; or ACT math score ≥ 22 or SAT math score ≥ 520 (scores must be less than 2 years old) and enrollment in Early Childhood or Special Education major, or in Middle Childhood major or pre-major with area of concentration different than Math.

Exclusions:
Not open to students with credit for 106.

Purpose of Course:
To develop an appreciation of, and basic competency in, the use of analytical thought in the development of a cohesive body of useful mathematical knowledge, with special emphasis on topics encountered in elementary and middle school mathematics programs. Math 1125 addresses the meaning of whole numbers, integers, rational numbers, and operations with these, number theory, and algebraic thinking. *Appropriate only for those preparing to become early childhood educators and for those preparing to teach subjects other than math in middle school.*

Follow-up Courses:
Math 1126.

Text:
Mathematics for Elementary Teachers, with Activity Manual, 4rd Edition, by Sybilla Beckmann, Pearson, ISBN for the package is 9780321836715 (loose-leaf).

Student Packet.

Mathematics 1125 **5 credits** **Mathematics for Elementary Teachers I**
Au, Sp
**Currently taught in either lecture/recitation or workshop format.*

Topics List:

1. Counting and the decimal system.
2. Fractions and integers and their meaning.
3. Addition and subtraction of fractions, decimals, and integers.
4. Multiplication of fractions, decimals, and integers.
5. Division of fractions, decimals, and integers.
6. Ratios and proportional reasoning.
7. Number theory: factors and multiples, LCM, GCF, divisibility tests, prime numbers, unique factorization, notations for fractions and decimals.
8. Algebraic thinking: writing expressions, solving equations, sequences.
9. Problem solving and justification are themes of the course.

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

Mathematics 1126 **5 credits** **Mathematics for**
Sp, Au **Elementary Teachers II**
**Currently taught in either lecture/recitation or workshop format.*

Catalog Description:
Continuation of 1125: Math 1126 involves geometry, measurement, number theory, algebraic thinking, counting techniques, probability, a mathematical reasoning for prospective elementary school teachers.

Prerequisite:
A grade of C- or above in 1125; and enrollment in Early Childhood or Special Education major, or in Middle Childhood major or pre-major with area of concentration different than Math.

Exclusions:
Not open to students with credit for 107.

Purpose of Course:
To develop an appreciation of, and basic competency in, the use of analytical thought in the development of a cohesive body of useful mathematical knowledge, with special emphasis on topics encountered in elementary and middle school mathematics programs. Math 1126 addresses basic geometric concepts and measurement, symmetry and rigid motions, congruence, similarity and scaling, coordinate geometry, algebraic thinking, linear functions, counting techniques and probability. *Appropriate for those preparing to become early childhood educators and for those preparing to teach subjects other than math in middle school.*

Text:
Mathematics for Elementary Teachers, with Activity Manual, 4rd Edition, by Sybilla Beckmann, Pearson, ISBN for the package is 9780321836715 (loose-leaf).
and
Student Packet.

Mathematics 1126 **5 credits** **Mathematics for**
Sp, Au **Elementary Teachers II**
**Currently taught in either lecture/recitation or workshop format.*

Topics List:

1. Spatial visualization and basic geometric concepts: angles, 2- and 3-D shapes and their properties.
2. Measurement: meaning of length, area, volume, measurement techniques, unit conversion, actions preserving area/volume, and scaling.
3. Transformations: symmetry, congruence, similarity.
4. Geometric constructions with various tools (compass, paper folding).
5. Algebraic thinking: expressions, measurement formulas, scaling, functions, use of formulas, graphs, and tables, sequences, and coordinate geometry.
6. Counting: inclusion/exclusion, fundamental counting principle, tree diagrams, permutations and combinations, Pascal's triangle.
7. Basic ideas of probability: Law of Large Numbers, sample and event spaces, use of tree diagrams, simulations, and discussion of common misconceptions.
8. Problem solving and justifications at multiple levels are themes of the course.

Catalog Description:
Algebraic, exponential, and logarithmic functions. Matrix algebra. Applications to business.

Prerequisite:
Math Placement Level N; C- or better in 1075; or credit for 104; or ACT math score $\geq$ 22 or SAT math score $\geq$ 520 (scores must be less than 2 years old).

Exclusions:
Not open to students with credit for 1131 or for any math course numbered 1149 or higher, or a quarter-system math course numbered 150 or higher.

Purpose of Course:
Math 1130 is a pre-calculus course with a finance section slanted toward a business program. The applications are business related.

Follow-up Course:
Math 1131

Text:
Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, 13th Edition; by Haeussler, Paul, and Wood; published by Pearson; ISBN 9781256966096

Topics List:

Review of Algebra:
- 0.7: Equations, In Particular Linear Equations.
- 0.8: Quadratic Equations.
- 1.2: Linear Inequalities.
- 1.3: Applications of Inequalities.
- 1.6: Sequences

Functions:
- 2.1: Functions.
- 2.2: Special functions.
- 2.3: Combinations of functions.
- 2.4: Inverse Functions.
- 2.5: Graphs of functions

3. Linear and Quadratic Functions:
- 3.1: Lines
- 3.2: Applications and Linear Functions.
- 3.3: Quadratic Functions
- 3.4: Systems of Linear Equations.
- 3.6: Applications of Systems of Equations.

4. Exponential and Logarithmic Functions:
- 4.1: Exponential Functions.
- 4.2: Logarithmic functions.
- 4.3: Properties of Logarithms.
- 4.4: Logarithmic and Exponential Equations.

5. Mathematics of Finance:
- 5.1: Compound Interest.
- 5.2: Present Value.
- 5.3: Interest Compounded Continuously.
- 5.4: Annuities
- 5.5: Amortization of Loans.

6. Matrix Algebra:
- 6.1: Matrices.
- 6.2: Matrix Addition and Scalar Multiplication.
- 6.3: Matrix Multiplication.
- 6.4: Solving Systems by Reducing Matrices.
- 6.6: Inverses

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

Mathematics 1131 **5 credits** **Calculus for Business**
Au, Sp

Catalog Description:
Survey of calculus of one and several variables; applications to business.

Prerequisite:
Math Placement Level L; C- or better in 1130, 1148, 1144, or 1150; credit for 130 or 148.

Exclusions:
Not open to students with credit for a math course numbered 1151 (151.xx) or higher, or for 132 or 1134.

Text:
Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences, 13th Edition, by Haeussler, Paul, Wood, published by Pearson: ISBN-10: 1-256-96609-6, ISBN-13: 978-1-256-96609-8.

Topics List:

1. Idea of limits, continuity, and derivative. Interpret derivative as a limit, slope, and rate of change.
2. Calculate derivatives of algebraic, exponential, and logarithmic functions.
3. Monotonicity, concavity, extrema of functions, second derivative tests, applications to graphing.
4. Applications: marginal analysis in business, optimization.
5. Anti-derivatives, separable first-order ODEs.
6. Riemann integral, substitution, Fundamental Theorem, area, applications.
7. Partial derivatives, extrema and second derivative test for two-variable functions, Lagrange multipliers. Applications to business.

Mathematics 1148 **4 credits** **College Algebra**
Au, Sp, Su

Catalog Description:
Functions: polynomial, rational, radical, exponential, and logarithmic. Introduction to right-angle trigonometry. Applications.

Prerequisite:
Math Placement Level N; C- or better in 1075; or credit for 104 or 148; or ACT math score ≥ 22 or SAT math score ≥ 520 (scores must be less than 2 years old).

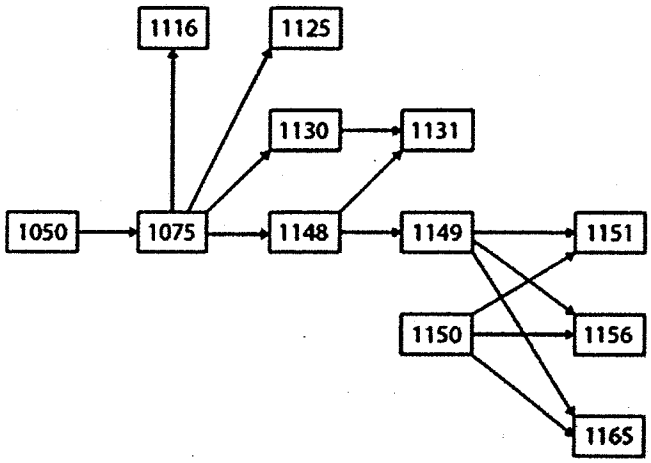
Exclusions:
Not open to students with credit for 1144 or 1150 or higher, or for a quarter-system math course numbered 150 or higher.

Purpose:
College Algebra provides students a college level academic experience that emphasizes the use of algebra and functions in problem solving and modeling, where solutions to problems in real-world situations are formulated, validated, and analyzed using mental, paper-and-pencil, algebraic and technology-based techniques as appropriate using a variety of mathematical notation. Students should develop a framework of problem-solving techniques (e.g., read the problem at least twice; define variables; sketch and label a diagram; list what is given; restate the question asked; identify variables and parameters; use analytical, numerical and graphical solution methods as appropriate; determine the plausibility of and interpret solutions). – Adapted from the MAA/CUPM CRAFTY 2007 College Algebra Guidelines. This course is intended to satisfy the requirements of the Ohio Board of Regents TMM001 College Algebra course with learning outcomes specified in: http://regents.ohio.gov/transfer/otm/otm-learning-outcomes.php

Text:
Precalculus: Mathematics for Calculus, 6th Edition, by J.Stewart, L.Redlin, and S.Watson, published by Cengage. ISBN Loose-leaf: 9781133904489 Hardback: 9780840068077

Technology: All students are required to have a graphing calculator, TI-83 or TI-84.
Note: Any calculators (including TI-89 and TI-92) that use a Computer Algebra System (CAS) are not permitted.

Sequencing Chart:



Topics List:

Week 1	Section 1.7 – Inequalities	
	Section 2.1 – What is a function?	*Ch 2 Functions*
Week 2	Section 2.2 – Graphs of functions	
	Section 2.3 – Getting information from a function	
Week 3	Section 2.4 – Average rate of change of a function	
	Section 2.5 – Transformations of functions	
Week 4	Section 2.6 – Combining functions	
	Section 2.7 – One-to-one functions and their inverses	
Week 5	Section 3.1 – Quadratic functions and models.	*Ch 3 Rational functions*
Week 6	Test 1	
	Section 3.2 – Polynomial functions	
	Section 3.3 – Dividing polynomials	
Week 7	Section 3.5 – Complex Numbers	
	Section 3.6 – Complex Zeros	
Week 8	Section 3.7 – Rational functions	
	Section 4.1 – Exponential functions.	*Ch 4 Exponentials & logarithms*
Week 9	Section 4.2 – The natural exponential function	
Week 10	Test 2	
	Section 4.3 – Logarithmic functions	
	Section 4.4 – Laws of logarithms	
Week 11	Section 4.5 – Exponential and logarithmic equations	
Week 12	Section 4.6 – Modeling with exponential and logarithmic equations; applications	
	Test 3	
	Section 10.1 – Linear systems (two variables)	*Ch 10 Systems of equations*
	Section 10.2 – Linear systems in several variables	
Week 13	Section 6.1 – Angle measure	*Ch 6 Trigonometry*
	Section 6.2 – Right triangle trigonometry	
Week 14	Section 6.3 – Trigonometric functions of angles	
	Comprehensive review, Final Exam	

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

Mathematics 1149 **3 credits** **Trigonometry**
Au, Sp, Su

Catalog Description:
Trigonometric functions and their properties. Vectors, polar coordinates and complex numbers.

Prerequisite:
C- or better in 1148, or permission of department.

Exclusions:
Not open to students with credit for 1144, or for any math course numbered 1150 (150) or higher.

Text:
Precalculus: Mathematics for Calculus, 6th Edition, by J. Stewart, L. Redlin, and S. Watson, published by Cengage. ISBN Loose-leaf: 9781133904489 Hardback: 9780840068077

Technology:
A graphing calculator is a required component in this course. It is recommended that you use a TI-83, TI-83 plus, or a TI-84. Note that the TI-89, TI-92, and calculators that use a Computer Algebra System are not permitted.

Topics List:

6.1 Angle Measure
6.2 Trigonometry of Right Triangles
6.3 Trigonometric Functions of Angles
5.1 The Unit Circle
5.2 Trigonometric Functions of Real Numbers
5.3 Trigonometric Graphs
5.4 More Trigonometric Graphs
5.5 Inverse Trigonometric Functions and Their Graphs

Midterm 1

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

6.4 Right Triangles
6.5 The Law of Sines
6.6 The Law of Cosines
7.1 Trig. Identities
7.2 Addition and Subtraction Formulas
7.3 Double/Half Angle and Product-Sum Formulas
7.4 Trig. Equations
7.5 More Trig. Equations
8.3 Polar Forms of Complex Numbers; De Moivre's Theorem
9.1 Vectors in Two Dimensions

Midterm 2

9.2 The Dot Product
11.1 Parabolas
11.2 Ellipses
11.3 Hyperbolas

Mathematics 1150 **5 credits** **Precalculus**
Au, Sp

Catalog Description:
Functions: polynomial, rational, radical, exponential, logarithmic, trigonometric, and inverse trigonometric. Applications.

Prerequisite:
Math Placement Level M.

Exclusions:
Not open to students with credit for 1144, 1148, 1149, for any higher numbered math course, or for any quarter-system math course 150 or higher.

Text:
Precalculus: Mathematics for Calculus, 6th Edition, by J. Stewart, L. Redlin, and S. Watson, published by Cengage, ISBN Loose-leaf: 9781133904489 Hardback: 9780840068077

Technology:
Every student is required to have a graphing calculator comparable in capability to a TI-83 or TI-84. However, calculators with symbolic algebra capabilities are not allowed during exams or quizzes.

Topics List:
2.1 Functions
2.2 Graphs of Functions
2.3 Information from Graphs
2.4 Average Rate of Change
2.5 Transformations of Functions
2.6 Combining Functions
2.7 One-to-One Functions and Their Inverses
3.1 Quadratic Functions
3.2 Polynomial Functions and their Graphs
3.3 Dividing Polynomials (Remainder and Factor Theorems)
3.6 Complex Zeros and Fundamental Theorem of Algebra
3.7 Rational Functions

Midterm 1

1.7 Inequalities (Polynomial and Rational Inequalities)
4.1/4.2 Exponential and Natural Exponential Functions
4.3 Logarithmic Functions
4.4 Laws of Logarithms
4.5 Exponential and Logarithmic Equations
4.6 Modeling with Exponential and Logarithmic Functions
6.1 Angle Measure
6.2 Trigonometry of Right Triangles
6.3 Trigonometric Functions of Angles
5.1 The Unit Circle
5.2 Trigonometric Functions of Real Numbers
5.3 Trigonometric Graphs
5.4 More Trigonometric Graphs
5.5 Inverse Trigonometric Functions and Their Graphs
6.4 Right Triangles
6.5 The Law of Sines
6.6 The Law of *Cosines*

Midterm 2

7.1 Trig. Identities
7.2 Addition and Subtraction Formulas
7.3 Double/Half Angle and Product-Sum Formulas
7.4 Trig. Equations
7.5 More Trig. Equations
8.3 Polar Forms of Complex Numbers; De Moivre's Theorem
9.1 Vectors in Two Dimensions
9.2 The Dot Product
10.1 Systems of Linear Equations in Two Variables
10.2 Systems of Linear Equations in Several Variables
11.1 Parabolas
11.2 Ellipses
11.3 Hyperbolas

Midterm 3

12.1 Sequences and Summation Notation
12.2 Arithmetic Sequences
12.3 Geometric Sequences

Mathematics 1151 **5 credits** **Calculus I**
Au, Sp, Su

Catalog Description:
Differential and integral calculus of one real variable.

Prerequisite:
Math Placement Level L, or C- or better in: 1150, or in both 1148 & 1149; or in 150 or 1144.

Exclusions:
Not open to students with credit for any higher numbered math class.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, by W. Briggs, L. Cochran, and B. Gillett, published by Pearson. ISBN: 1256776467

Topics List:
1.3 Inverse, Exponential, and Logarithmic Functions
1.4 Trigonometric Functions and Their Inverses
2.1 The Idea of Limits
2.2 Definitions of Limits
2.3 Techniques for Computing Limits
2.4 Infinite Limits
2.5 Limits at Infinity
2.6 Continuity

Midterm 1

3.1 Introducing the Derivative
3.2 Rules of Differentiation
3.3 The Product and Quotient Rules
3.4 Derivatives of Trigonometric Functions
3.5 Derivative as Rates of Change
3.6 The Chain Rule
3.7 Implicit Differentiation
3.8 Derivatives of Logarithmic and Exponential Functions
3.9 Derivatives of Inverse Trigonometric Functions
3.10 Related Rates
4.1 Maxima and Minima
4.2 What Derivatives Tell Us

Midterm 2

4.3 Graphing Functions
4.4 Optimization Problems
4.5 Linear Approximations and Differentials
4.6 Mean Value Theorem
4.7 L'Hospital's Rule
4.8 Newton's Method
4.9 Antiderivatives
5.1 Approximating Areas under Curves

Midterm 3

5.2 Definite Integrals
5.3 Fundamental Theorem of Calculus
5.4 Working with Integrals
5.5 Substitution Rule
6.1 Velocity and Net Change

Final

Mathematics 1152 **5 credits** **Calculus II**
Au, Sp, Su

Catalog Description:
Integral calculus, sequences and series, parametric curves, polar coordinates, vectors.

Prerequisite:
C- or better in 1151, 1156, 152.xx, 161.xx or 161.01H; or 114 or 1114.

Exclusions:
Not open to students with credit for any higher numbered math class or with credit for quarter-system Math courses numbered 153.xx or above.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, 1st OSU custom edition, by Briggs, Cochran, Gillett, published by Pearson, ISBN: Loose-leaf/Full Bk: 978125678771X, Hardcover/Full Bk: 9781256776467.

Topics List:

1. Regions between Curves
2. Volume by Slicing, Volume by Shells
3. Lengths of Curves
4. Physical Applications
5. Exponential Models
6. Basic Approaches to Integration
7. Integration by Parts
8. Trigonometric Integrals
9. Trig Substitution
10. Partial Fractions
11. Improper Integrals
12. Basic Ideas of Differential Equations
13. Differential Fields and Euler's Method
14. Separable Differential Equations
15. Sequences

Cont.

16. Series
17. Divergence and Integral Tests
18. Ratio and Root Tests
19. Comparison Tests
20. Alternating Series
21. Approximate Functions with Polynomials
22. Properties of Power Series
23. Taylor Series
24. Parametric Equations
25. Polar Equations
26. Calculus in Polar Coordinates
27. Conic Sections (Conic Sections in Polar optional)
28. Vectors in the Plane and 3-space (optional)
29. Dot Products (optional)
30. Cross Products (optional)
31. Lines and Curves in Space (optional)

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

Mathematics 1156 **5 credits** **Calculus for Biological Sciences**
Au

Catalog Description:
Limits, continuity, derivatives, mean value theorem, extrema, curve sketching, related rates, differentiation of the trig, log, and exponential functions, basic integration techniques, with particular motivations from and application to the Biological Sciences.

Prerequisite:
A grade of C- or above in 1148 and 1149, or a grade of C- or above in 1150, or credit for 150, or Math Placement Level L. Not open to students with credit for 1151 (151.xx) or above. GE quant reason math and logical analysis course.

Exclusions:
Not open to students with credit for 1151, or with credit for any higher numbered math class.

Purpose of Course:
To provide students with a solid foundation in one-variable differential calculus, to model and analyze phenomena in the Biological Sciences.

Follow-up Course:
Math 1157

Text:
Calculus for Biology and Medicine, 3rd Edition, by Claudia Neuhauser, Pearson, ISBN 9780321644688

Topics List:

1.2	Elementary Functions
1.3/2.1	Graphing/Exponential Growth and Decay
2.2	Sequences
3.1-3.4	Limits and Continuity
3.5	Properties of Continuous Functions
4.1	Derivatives
4.2-4.3	Rules of Differentiation, Product and Quotient Rules
4.4	Chain Rule and Higher Derivatives
4.5-4.7	Derivatives of Special Functions and Inverse Functions
5.1-5.3	Extrema, Mean Value Theorem, Monotonicity, Concavity, Inflection Points
5.4	Optimization
5.5	L'Hospital's Rule
5.8	Antiderivatives
6.1	The Definite Integral
6.2	The Fundamental Theorem of Calculus
6.3	Applications of Integration
7.1-7.2	Integration Techniques
	Also: Small-group Projects

Mathematics 1157 **5 credits** **Mathematical Modeling**
Sp **for the Biological Sciences**

Catalog Description:
Models in life sciences using multivariable calculus, linear algebra, dynamical systems, and ordinary differential equations.

Prerequisite:
C- or better in: 1156, 1151, 1161.xx or 1181H; or credit for 152.xx.

Exclusions:
Not open to students with credit for 1152 or with credit for any higher numbered math class.

Purpose of Course:
To provide students with a solid foundation in one-variable calculus, to introduce multi-variable tools in a biological setting, to model and analyze phenomena in the life sciences.

Text:
Calculus for Biology and Medicine, 3rd Edition, by Claudia Neuhauser, Pearson, ISBN 9780321644688

Topics List:

7.3	Rational Functions and Partial Fractions
7.5	Numerical Integration
7.6	Taylor Approximation
8.1	Solving Differential Equations
8.2	Equilibria and Their Stability
9.1-9.2	Linear Systems and Matrices
9.3	Linear Maps, Eigenvectors, an Eigenvalues
10.3	Multivariable functions & Partial Derivatives
10.4	Tangent Planes, Differentiability, and Linearization
11.1-11.2	Linear Systems: Theory and Applications
11.3-11.4	Nonlinear Autonomous Systems: Theory and Applications
Also:	Small-group Projects

Markov Chains

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

Mathematics 1161.01 **5 credits each** **Accelerated Calculus I**
Mathematics 1161.02 **Accelerated Calculus I for**
Au **Honors Engineers**

Catalog Description:
Differential and integral calculus of one real variable.

Prerequisites:
Math Placement Level L and previous calculus experience.

Exclusions:
For 1161.01: Not open to students with credit for any math course numbered 1152 or higher, or for the quarter-system math courses 151.xx and 152.xx, or for any quarter-system course numbered 162.xx or higher.
For 1161.02: Intended for students in Freshman Engineering Honors.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, 2nd OSU custom edition, by Briggs, Cochran, Gillett, Person, ISBN: 9781269753449

Topics:

2.1; 2.2	The Idea of Limits; Definition of Limits
2.2; 2.3	Definition of Limits; Limit Laws
2.4; 2.5	Infinite Limits; Limits at Infinity
2.5; 2.6	Limits at Infinity; Continuity, the Intermediate Value Theorem
2.7	Precise Definition of Limits
3.1	Introducing the Derivative
3.2; 3.3	Rules of Differentiation; Product and Quotient Rules
3.4; 3.5	Derivatives of Trig Functions; Derivatives as Rate of Change
3.5; 3.6	Derivatives as Rate of Change; The Chain Rule
3.7	Implicit Differentiation

Midterm 1

3.8; 3.9	Derivatives of Logarithms and Exponential Functions; Derivatives of Inverse Functions
3.10	Related Rates
4.1	Maxima and Minima
4.2; 4.3	What derivatives Tell Us; Graphing
4.4	Optimization Problems
4.5; 4.6	Linear Approximations and Differentials; Mean Value Theorem
4.6; 4.7	Mean Value Theorem; L'Hopital's Rule
4.9	Antiderivatives
5.1	Approximating Areas under Curves, Sigma Notation
5.2	Definite Integrals
	Midterm 2
5.3	Fundamental Theorem of Calculus
5.4; 5.5	Working with Integrals; Substitution Rule
5.5; 6.1	Substitution Rule; Velocity and Net Change
6.2	Regions between Curves
6.3	Volumes by Slicing
6.4	Volumes by Shells
6.5; 6.6 11.5	Lengths of Curves; Surface Area
6.7	Physical Applications: Density & Mass, Work, Lifting Problems, Force & Pressure
6.8; 6.9	Log and Exponential Functions Again; Exponential Growth and Decay
7.1; 7.2	Integration: Basic Approaches; Integration by Parts
	Midterm 3
7.3	Trig Integrals
7.4	Trig Substitutions
7.5	Partial Fractions
7.8	Improper Integrals
	Final

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

Mathematics 1165 **5 credits** **Math for Middle School Teachers**
Au

Catalog Description:
Algebra and reasoning for middle school teachers.

Prerequisite:
A grade of C- or above in 1148 and 1149, or grade of C- or above in 1150, or credit for 150, or Math Placement Level L; and enrollment in Middle Childhood Education major within either College of Arts and Sciences or College of Education and Human Ecology with Math as an Area of Concentration.

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

Follow-up Courses:
Math 1166, Math 2167, and Math 2168

Text:
Course Notes, by B. Snapp
Recommended Text: Algebra Connections, by Papick, published by Pearson, ISBN 9780131449282

Topics List:
1. Number systems (whole, integer, rational, real): uses, notations (including place value), and comparison of size. Addition and Subtraction
2. Division algorithm, Euclidean algorithm, Diophantine equations, counting techniques.
3. Algebra: polynomials, their structure and arithmetic, division algorithm.
4. Solving equations: linear, quadratic, etc., using complex numbers.
5. Introduction to mathematical induction.
6. Applications: modeling real-world topics.
7. Problem solving (a theme throughout the course).

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

Catalog Description:
Geometry for middle school teachers.

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

Prerequisite:
C- or better in 1165, and enrollment in Middle Childhood Education major with Math as an Area of Concentration.

Follow-up Courses:
Math 2167 and Math 2168

Text:
Course Notes.

Topics List:
1. Visual reasoning via "proofs without words." Measurement (also teaching measurement in middle school)
2. Geometric constructions, congruence, similarity, and problem solving.
3. Coordinate geometry with emphasis on solving equations.
4. Non-Euclidean geometries.
5. Geometric transformations coordinate geometry, complex numbers.
6. Scaling and relationship between perimeter and area.
7. Measurement issues.
8. Modeling real-world situations.

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

Mathematics 1172 **5 credits** **Engineering Mathematics A**
Au, Sp, Su

Catalog Description:
Techniques of integration, Taylor series, differential calculus of several variables.

Prerequisites:
C- or better in 1151, 152.xx, 1156, 1161.xx, 161.01H, 161.xx, 1114 or 114.

Exclusions:
Not open to students in math, pre-actuarial science, or actuarial science. Not open to students with credit for any higher numbered math class, or for 1152; or for 254.xx or higher numbered math class.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, 1st OSU custom edition, by Briggs, Cochran, Gillett, published by Pearson,
ISBN: Loose-leaf/Full Bk: 978125678771X, Hardcover/Full Bk: 9781256776467

Topics:

6.2	Regions between Curves
6.3	Volume by Slicing
6.4	Volume by Shells
6.5	Lengths of Curves
6.7	Physical Applications
7.1	Basic Approaches to Integration
7.2	Integration by Parts
7.3	Trigonometric Integrals

Midterm 1

7.4	Trig Substitution
7.5	Partial Fractions
7.8	Improper Integrals
9.1	Overview of Sequences and Series
9.2	Sequences
9.3	Series (and Idea of Convergence)
9.4	Divergence Test (and Properties of Convergent Series only)
9.5	Ratio Test (only)
10.1	Approx functions with Polynomials
10.2	Properties of Power Series
10.3, 10.4	Taylor Series
	Midterm 2
11.1	Parametric Equations
11.2	Polar Equations
11.3	Calculus in Polar Coordinates
11.4	Conic Sections (Conic Sections in Polar optional)
12.1, 12.2	Vectors in the Plane and 3-Space
12.3, 12.4	Dot Products, Cross Products
12.5	Lines and Curves in Space
12.6	Calculus of Vector-Valued Functions
12.7	Motion in Space
12.8	Lengths of Curves
	Midterm 3
13.1	Planes and Surfaces
13.2	Graphs and Level Curves
13.3	Limits and Continuity
13.4	Partial Derivatives
13.5	The Chain Rule
13.6	Directional Derivatives, Gradient
	Final

Mathematics 1181H **5 credits** **Honors Calculus I**
Au

Catalog Description:
Single variable calculus treated in depth.

Prerequisites:
1151 or 151.xx, and permission of department.

Exclusions:
Not open to students with credit for any higher numbered math class.

Text:
Calculus with Analytic Geometry, 2nd edition, by Simmons, published by McGraw-Hill, ISBN: 9780070576424

Topics:

2.1	The Problem of Tangents
2.2	How to Calculate the Slope of the Tangent
2.3	The definition of the Derivative
2.4	Velocity and Rate of Change
2.5	The Concept of a Limit; Two Trigonometric Limits
A2	Theorems about Limits;
3.1	Derivatives of Polynomials
3.2	The Product and Quotient Rules
3.3	Composite Functions and the Chain Rule
3.4	Some trig Derivatives;
3.5	Implicit Functions and Fractional Exponents
3.6	Derivatives of Higher Order
12.2	Indeterminate Form 0/0, L'Hopital's Rule
4.1	Increasing and Decreasing Functions, Maxima and Minima
4.2	Concavity and Points of Inflection
4.3	Applied Maxima and Minima Problems
4.4	Reflection & Refraction
4.5	Related Rates
2.6	Continuous Functions
A4	The Mean Value Theorem
	Midterm I
5.2	Differentials and Tangent Line Approx'n
5.3	Indefinite Integrals, Integration by Substitution;
5.4	Differential Equations, Separation of Variables
6.1	Introduction

6.2	The Problem of Areas.
6.3	The Sigma Notation and Certain Special Sums
6.4	Area under a Curve, Definite Integrals, Riemann
6.5	The Computation of Areas as Limits;
6.6	The Fundamental Theorem of Calculus
6.7	Algebraic and Geometric Areas
7.2	Area between Two Curves;
7.3	Volumes: The Disk Method
7.4	Volumes: The Method of Cylindrical Shells
7.5; 7.6	Arc Length; Area of a Surface of Revolution
7.7	Work and Energy
8.2	Review of Exponents and Logarithms;
8.3	The number e and the function y=e^x
8.4	The Natural Logarithm Function, Euler
8.5	Applications, Population Growth and Radioactive Decay
9.1; 9.2	Review of Trig.; Der've and Integrals of Sin and Cos
9.3; 9.4	Der've of the Other Four Fns
9.5	The Inverse Trig Functions
9.6; 9.7	Simple Harmonic Motion; ("Optional") Hyperbolic Functions
	MIDTERM 2
10.1; 10.2	Basic Formulas; Method of Substitution
10.3: 10.4	Certain Trig Integrals; Trig Substitutions;
10.5; 10.6	Completing the Square
10.7	Integration by Parts
10.8	Strategy for Dealing with Integrals
12.2; 12.3	Indeterminate Form 0/0, L'Hopital's Rule; Other Indeterminate Forms
12.3; 12.4	Improper Integrals
13.1	What is an Infinite Series?;
13.2	Convergent Sequences
13.3	Convergent and Divergent Series
13.4	General Properties of Convergent Series
13.5	Series of Non-negative Terms, Compar. Tests
13.6	Integral Test, Euler's Constant
13.7	Ratio and Root Test
13.8	Alternating Series Test, Absolute Convergence
	MIDTERM 3
14.2	The Interval of Convergence
14.3	Differentiation and Integration of Power Series
14.4	Taylor' Series and Taylor's Formula
14.5	Computations Using Taylor's Formula
14.6	Applications to Differential Equations
14.8	Operations on Power Series
	FINAL

Mathematics 1187H **1-2 credits each** **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. It is preparation for the National Putnam Mathematics Exam. This course is repeatable to a maximum of 6 credit hours, and is graded S/U. This course may not be counted in a major or minor program in Mathematics.

Topics:
Interesting special problems as chosen by the instructor.

Catalog Description:
Seminar on mathematical topics for beginning math and actuarial science majors.

Prerequisite:
Enrollment in math or actuarial science major, or permission of department.

Topics List:
1. Overview of the scope of mathematics, its subfields, and its applications.
2. Discussion of the OSU math major and differences among the tracks.
3. Outline of programs and activities that can benefit math majors.
4. Presentation of various different sorts of career opportunities for math majors.

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

Mathematics 2153 **4 credits** **Calculus III**
Au, Sp

Catalog Description:
Multivariable differential and integral calculus.

Prerequisites:
C- or better in 1152, 1172, 1534, 1544, 1181H, or 4181H; or credit for 153.xx, 154, 162.xx, or 162.01H.

Exclusions:
Not open to students with credit for any higher numbered math class, or for any quarter math class numbered 254 or higher.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, 1st OSU custom edition, by Briggs, Cochran, Gillett, Pearson, published by Pearson, ISBN: Loose-leaf/Full Book: 978125678771X, Hardcover/Full Book: 9781256776467

Topics:

CHAPTER 12. Vectors and Vector-Valued Functions
- Section 1. Vectors in the Plane
- Section 2. Vectors in Three Dimensions
- Section 3. Dot Products
- Section 4. Cross Products
- Section 5. Lines and Curves in Space
- Section 6. Calculus of Vector-Valued Functions
- Section 7. Motion in Space
- Section 8. Length of Curves
- Section 9. Curvature and Normal Vectors

CHAPTER 13. Functions of Several Variables
- Section 1. Planes and Surfaces, and brief conic section review
  via pages 761 to 766 of Section 11.4
- Section 2. Graphs and Level Curves
- Section 3. Limits and Continuity
- Section 4. Partial Derivatives
- Section 5. The Chain Rule
- Section 6. Directional Derivatives and the Gradient
- Section 7. Tangent Planes and Linear Approximation
- Section 8. Maximum/Minimum Problems
- Section 9. Lagrange Multipliers

CHAPTER 14. Multiple Integration
- Section 1. Double Integrals over Rectangular Regions
- Section 2. Double Integrals over General Regions
- Section 3. Double Integrals in Polar Coordinates
- Section 4. Triple Integrals
- Section 5. Triple Integrals in Cylindrical and Spherical Coordinates
- Section 6. Integrals for Mass Calculations
- Section 7. Change of Variables in Multiple Integrals

CHAPTER 15. Vector Calculus
- Section 1. Vector Fields
- Section 2. Line Integrals
- Section 3. Conservative Vector Fields
- Section 4. Green's Theorem
- Section 5. Divergence and Curl
- Section 6. Surface Integrals
- Section 7. Stokes' Theorem
- Section 8. Divergence Theorem

Mathematics 2162.01 (Sp) **5 credits each** **Accelerated Calculus II**
Mathematics 2162.02 (Au, Sp) **Accelerated Calculus II for Honors Engineers**

Catalog Description:
Multivariable calculus; introduction to Taylor series.

Prerequisites:
C- or better in 1161.xx or 1181H.

Exclusions:
For 2162.01: Not open to students with credit for any higher numbered math class numbered 2162 or higher.
For 2162.02: Intended for students in Freshman Engineering Honors and not open to students with credit for any higher numbered math class numbered 2162 or higher.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, 2nd OSU custom edition, by Briggs, Cochran, Gillett, Person, published by Pearson, ISBN: 9781269753449

Topics:

9.1; 9.2	An Overview; Sequences
9.2; 9.3	Sequences; Infinite Series
9.4	Divergence and Integral Tests
9.5	Ratio, root, and Comparison Tests
9.5; 9.6	Ratio, root, and Comparison Tests; Alternating Series;
10.1; 10.2	Approximating Functions with Polynomials; Properties of power Series
10.3; 10.4	Taylor Series; Working with Taylor Series
11.1; 11.2	Parametric Equations; Polar Coordinates
11.2; 11.3	Polar Coordinates; Calculus in Polar Coordinates
	Midterm 1

12.1; 12.2	Vectors in the Plane; Vectors in Three Dimensions
12.3;12.4	Dot Products; Cross Products
12.5	Lines and Curves in Space
12.6	Calculus of Vector-Valued Functions
12.7; 12.8	Motion in Space; Length of Curves
12.9	Curvature and Normal Vectors
13.1; 13.2	Planes and Surfaces; Graphs and Level Curves
13.3	Limits and Continuity
13.4;13.5	Partial Derivatives; Chain Rule
13.6	Directional derivative and the Gradient
	MIDTERM 2
13.7	Tangent Plane and Linear Approximation
13.8	Maximum/Minimum Problems
13.9	Lagrange Multipliers
14.1; 14.2	Double Integral over Rectangular Regions; Double Integrals over General Regions
14.2; 14.3	Double Integrals over General Regions; Double integrals in Polar Coordinates
14.4; 14.5	Triple Integrals; Triple Integrals in Cylindricals and Sphericals
14.5; 14.6	Triple Integrals in Cylindricals and Sphericals; Integrals for Mass Calculations
15.1	Vector Fields
15.2	Line Integrals
15.3	Conservative Vector Fields
	MIDTERM 3
15.4	Green's Theorem
15.5	Divergence and Curl
15.6	Surface Integrals
15.7	Stokes' Theorem
15.8	Divergence Theorem

Mathematics 2167 **3 credits** **Calculus for Middle School Teachers**
Au

Catalog Description:
Concepts of Calculus for Middle School Math teachers.

Prerequisite:
A grade of C- or above in 1165, or credit for 1164 or 110; and enrollment in Middle Childhood Education major or pre-major with Math as area of concentration.

Exclusions:
Not open to students with credit for 111.

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

Follow-up Courses:
Math 2168

Text:
Under Consideration.
Optional text: ***Calculus Connections: Mathematics for Middle School Teachers***. By Asma Harcharras and Dorina Mitrea (2007). Published by Prentice Hall. ISBN: 0-13-144923-0
Supplementary Text: Course Notes

Topics List:
1. Rates described pictorially, in writing, and with symbols.
2. Informal and formal measurement of (instantaneous) rates and their connection to middle school mathematics.
3. Informal and formal measurement of (accumulated) areas and their connection to middle school mathematics.
4. The Fundamental Theorem of Calculus.
5. Applications of differential calculus.
6. Applications of integral calculus.

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

Mathematics 2168 **3 credits** **History of Mathematics**
Sp **for Middle School Teachers**

Prerequisite:
C- or better in 2167; or credit for 111. Limited to Middle Childhood majors and pre-majors with Math as an Area of Concentration.

Catalog Description:
Historical and mathematical discussion of topics in the middle school math curriculum.

Purpose of Course:
The purpose of the course is to prepare prospective middle school math teachers. In particular, it intends to deepen and extend prospective teachers' connections among topics in mathematics through the study of the history of mathematics, as well as continuing to develop their ability to reason with and communicate that knowledge.

Follow-up Courses:
None

Text:
Math through the Ages: A Gentle History for Teachers & Others, Expanded Edition, by Berlinghoff & Bouvea, published by Mathematical Association, ISBN: 9780883857366

Course Packet

Topics List:

1. History of Mathematics, from ancient to modern times.
2. Development of number systems, operations, geometry, trigonometry, algebra, calculus, statistics, and probability.
3. Applications: modeling real-world topics.
4. Problem solving (a theme throughout the course).

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

Mathematics 2173 **3 credits** **Engineering Mathematics B**
Au, Sp

Catalog Description:
Multiple integrals, line integrals, vector fields, second order ordinary differential equations.

Prerequisite:
Math 1172, 1544, or 154.

Exclusions:
Not open to students with credit for 1152, 2153, or for any higher numbered math class, or for any quarter-system math class numbered 254 or higher.

Text:
Calculus for Scientists and Engineers: Early Transcendentals, 2nd OSU custom edition, by Briggs, Cochran, Gillett, published by Pearson, ISBN: 9781269753449

Topics List:

13.6	(Review of) Directional Derivatives and the Gradient Vector
13.8	Maximum and Minimum Values
13.9	Lagrange Multipliers
14.1	Double Integrals over Rectangular Regions
14.2	Double Integrals over General Regions
14.3	Double Integrals in Polar Coordinates
	Midterm 1
14.4	Triple Integrals
14.5	Triple Integrals in Cylindrical & Spherical Coordinates
14.7	Change of Variables in Multiple Integrals
15.1	Vector Fields
15.2	Line Integrals
15.3	Conservative Vector Fields
	Midterm 2

16.1	Basic Ideas of Second Order ODE's
Appendix C	Complex Arithmetic
16.2	Linear Homogeneous Equations
16.3	Linear Homogeneous Equations
16.4	Applications; Complex Forcing Functions

Final

Mathematics 2174 **3 credits** **Linear Algebra and**
Au, Sp **Differential Equations**

Catalog Description:
Matrix theory, eigenvectors and eigenvalues, ordinary and partial differential equations.

Prerequisite:
2173 and either major in ENG, Physics, or Chemistry or permission of math department.

Exclusions:
Not open to students with credit for both (i) 2415 (415) or 2255 (255) and (ii) 2568 (568 or 571).

Text:

Part II: Elementary Ordinary & Partial Differential Equations, OSU custom edition, by Boyce, published by Wiley, ISBN: 9781119934462
Introduction to Linear Algebra, 5th edition, by Johnson, Riess and Arnold, published by Pearson, ISBN: 9780321628217

Topics List:

Part One = Matrix Algebra
Textbook sections from Arnold, Riess, and Johnson's *Introduction to Linear Algebra*, 5th edition
Chapter 1: Matrices and Linear Systems of Equations
Chapter 3: The Vector Space R^n
Chapter 4: The Eigenvalue Problem

1.1 Introduction and Gaussian Elimination and Systems of Linear Equations
1.2 Echelon Form and Gauss-Jordan Elimination
1.3 Consistent Systems of Linear Equations
1.5 Matrix Operations
1.6 Algebraic Properties of Matrix operations
1.7 Linear Independence and Nonsingular Matrices
1.9 Matrix Inverses and the Properties
3.1-3.2 Review and Vector Space Properties in R^n
3.3 Examples of Subspaces
3.4 Basis for Subspaces; Dimension

Midterm I

4.1 The Eigenvalue Problem for 2x2 Matrices
4.2 Determinants and the eigenvalue Problem
4.4 Eigenvalues and characteristic Polynomial
4.5 Eigenvectors and Eigenspaces
4.6 Complex Eigenvalues and Eigenvectors
4.7 Similarity Xformations and Diagonalization

Part Two = Systems of Linear Differential Equations
Textbook Sections from Boyce & DiPrima's *Part II: Elementary Ordinary & Partial Differential Equations*

Ch. 7: Systems of First Order Linear Equations (no lectures, but assigned as an independent class project)

Midterm 2

Part Three = Partial Differential Equations and Fourier Series
Textbook Sections from Boyce & DiPrima's *Part II: Elementary Ordinary & Partial Differential Equations*

10.1 Two point Boundary Value Problem
10.2 Fourier Series
10.3 The Fourier Convergence Theorem
10.4 Even and Odd Functions
10.5 Separation of Variables; Heat Conduction Equation
10.6 Other Heat Conduction Problems
10.7 The Wave Equation; Vibrations of an Elastic String
10.8 Laplace's Equation (optional)

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

Mathematics 2177 **4 credits** **Mathematical Topics for Engineers**
Au, Sp

Catalog Description:
Multiple integrals, line integrals; matrix algebra; linear (ordinary and partial) differential equations.

Prerequisite:
Major, pre-major, or minor in BiomedE, CEEGS, FABEng, MatScEn, CBE, or WeldEn; and: 1172, 2153, 1544 (154), 254.xx, 263.xx, 263.01H, or 264H

Exclusions:
Not open to students with credit for 2174 or 5520H; or with credit for both (i) 2415 (415), 2255 (255) or 4512 (512) and (ii) 2568 (568 or 571).

Text:
Math 2177, Custom Edition for OSU, Pearson, ISBN-13 978-1-256-82676-7 or ISBN-10 1-256-82676-6 –**OR**– the textbooks listed below.

Topics List:

PART ONE: Multivariable Integral Calculus
Textbook Sections from *Calculus for Scientists and Engineers: Early Transcendentals*, by Briggs, Cochran, Gillett and Shulz, Chapters 13-15

2177 Custom	Original Text	Topic
1.8	13.8	Maximum/Minimum Problems
1.9	13.9	Lagrange Multipliers
2.1	14.1	Double Integrals over Rectangular Regions
2.2	14.2	Double Integrals over General Regions
2.3	14.3	Double Integrals in Polar Coordinates
2.4	14.4	Triple Integrals
2.5	14.5	Triple Integrals in Cylindrical and Spherical Coordinates
2.7	14.7	Change of Variables in Multiple Integrals
3.1	15.1	Vector Fields
3.2	15.2	Line Integrals
3.3	15.3	Conservative Vector Fields
Midterm 1		

PART TWO: Matrices and Linear Systems of Equations
Textbook Sections from *Introduction to Linear Algebra*, by Johnson, Riess, and Arnold, 5th edition, Chapter 1: Matrices and Systems of Linear Equations

2177 Custom	Original Text	Topic
4.1	1.1	Introduction to Matrices and Systems of Linear Equations
4.2	1.2	Echelon Form and Gauss-Jordan Elimination
4.3	1.3	Consistent Systems of Linear Equations
4.4	4.4	Applications (optional)
4.5	1.5	Matrix Operations
4.6	1.6	Algebraic Properties of Matrix operations
4.7	1.7	Linear Independence and Nonsingular Matrices
4.8	1.8	Data Fitting, Numerical Integration and Numerical Differentiation
Midterm 2		

PART THREE: 2nd Order Constant Coefficient O.D.E.' s
Textbook Sections from *Calculus for Scientists and Engineers: Early Transcendentals*, by Briggs, Cochran, Gillett and Shulz, Chapter 16 and Appendix C

2177 Custom	Original Text	Topic
5.1	16.1	Basic Ideas
Appx C	Appx C	Complex Numbers
5.2	16.2	Linear Homogeneous Equations
5.3	16.3	Linear Nonhomogeneous Equations
5.4	16.4	Applications
Midterm 3		

PART FOUR: Fourier Series & Partial Differential Equations
Textbook Sections from *Fundamentals of Differential Equations and Boundary Value Problems*, by Nagle, Saff and Snider, 8th Edition, Chapter 10

2177 Custom	Original Text	Topic
6.1	10.1	Introduction: A Model for Heat Flow
6.2	10.2	Method of Separation of Variables
6.3	10.3	Fourier Series
6.4	10.4	Fourier Cosine and Sine Series
6.5	10.5	The Heat Equation
6.6	10.6	The Wave Equation

Mathematics 2182H **5 credits** **Honors Calculus II**
Sp

Catalog Description:
Multivariable calculus treated in depth.

Prerequisite:
C or better in 1181H or 4181H.

Exclusions:
Not open to students with credit for both 162.01H and 263.01H

Text:
Calculus with Analytic Geometry, 2nd Edition, by George F. Simmons, published by McGraw-Hill, ISBN: 0070576424

Topics List:

15.1; 15.2	Conic sections: Ellipse, Parabola, Hyperbola
15.3; 15.4	Conic sections: Ellipse, Parabola, Hyperbola
16.1	Polar coordinate system
16.2	Graphs of polar equations
16.3	Polar Equations of conics and spirals
16.3; 16.4	Polar Equations of conics and spirals; Arc length and tangent lines
16.5	Areas in polar coordinates
17.1	Parametric Equations of Curves
17.2	Cycloids and other similar Figures
17.3	Vector Algebra, the Unit Vectors *i* and *j*;
17.4	Derivatives of Vector Functions, Velocity and Acceleration
17.5	Curvature and the Unit Normal Vector
17.6	Tangential and Normal Components of Acceleration
17.7	Kepler's Laws and Newton's Law of Universal Gravitation

Midterm 1

18.1 Coordinates and Vectors in 3-D Space
18.2 The Cross Product of Two Vectors
18.3 The Dot Product of Two Vectors
18.4 Lines and Planes
18.5 Cylinders and Surfaces of Revolution
18.6 Quadratic Surfaces;
18.7 Cylindrical and Spherical Coordinates
19.1 Function of Several Variables
19.2 Partial Derivatives
19.3 The Plane Tangent to a Surface
19.4 Increments and Differentials, the Fundamental Lemma
19.5 Directional Derivatives and the Gradient
19.6 The Chain Rule for Partial Derivatives
19.7; 19.8 Maximum and Minimum Problems
19.10 Implicit Functions

Midterm 2

20.1 Volumes as Iterated Integrals
20.2 Double Integrals and Iterated Integrals
20.3 Physical Applications of Double Integrals
20.4 Double Integrals in Polar Coordinates
20.5 Triple Integrals
20.6 Cylindrical Coordinates
20.7 Spherical Coordinates, Gravitational Attraction
20.8 Area of Curved Surfaces

Midterm 3

21.1 Line Integrals in the Plane
21.2 Independence of Path, Conservative Fields
21.3 Green's Theorem
21.4 Surface Integrals and Gauss' Theorem
21.5 Stokes' Theorem

Mathematics 2255 | **3 credits** | **Differential Equations and Their Applications**
Au, Sp, Su

Catalog Description:
Ordinary differential equations, their series solutions, numerical methods, Laplace transforms, physical applications.

Prerequisite:
C- or better in 2153, 2162.xx, 2173, 2182H, or 4182H; or credit for 254.xx, 263.xx, 263.01H, or 264H.

Text:
Ordinary Differential Equations and their Applications, OSU custom edition, by Boyce, published by Wiley, ISBN 9781119934455

Topics List:

INTRODUCTION
1.3 Classification of Differential Equations
2.1 Linear Equations with Variable Coefficients

FIRST ORDER DIFFERENTIAL EQUATIONS
2.2 Separable Equations
2.4 Differences between Linear and Nonlinear Equations
2.5 Autonomous Equations and Population Dynamics
2.6 Exact Equations and Integrating Factors
2.7 Numerical Approximations: Euler's Method
2.8 The Existence and Uniqueness Theorem
2.9 First Order Difference Equations

SECOND ORDER LINEAR EQUATIONS
3.1 Homogeneous Equations with Constant Coefficients
3.3 Complex Roots of the Characteristic Equation
3.2 Solutions of Linear Homogeneous Equations; the Wronkian
3.4 Repeated Roots; Reduction of Order

Midterm 1

3.5 Nonhomogeneous Equations; Method of Undetermined Coefficients
3.6 Variation of Parameters
3.7 Mechanical and Electrical Vibrations
3.8 Forced Vibrations

THE LAPLACE TRANSFORM
6.1 Definition of the Laplace Transform
6.3 Step Functions
6.2 Solution of Initial Value Problems
6.4 Differential Equations with Discontinuous Forcing Functions
6.5 Impulse Functions
6.6 The Convolution Integral

Midterm 2

HIGHER ORDER LINEAR EQUATIONS
4.1 General Theory of nth Order Equations
4.2 Homogeneous Equations with Constant Coefficients
4.3 The Method of Undetermined Coefficients Material
4.4 The Method of Variation of Parameters

SERIES SOLUTIONS OF SECOND ORDER LINEAR EQUATIONS
5.1 Review of Power Series
5.2 Series Solutions near an Ordinary Point, Part I
5.3 Series Solutions near an Ordinary Point, Part II
5.4 Euler's Equation; Regular Singular Points

Midterm 3

5.5 Series Solutions near a Regular Singular Point, Part I
5.6 Series Solutions near a Regular Singular Point, Part II
5.7 Bessel's Equation

Mathematics 2366 **2 credits** **Introduction to Discrete Mathematics**
Sp

Catalog Description:
Mathematical reasoning, logic, sets, functions, recursive definitions, elementary counting principles.

Prerequisites:
C- or better in 1131 or 1151; credit for 132 or 152.xx; or permission of department.

Exclusions:
Open only to majors in MIS (Management Information Systems). Not open to students with credit for 366.

Text:
Discrete Mathematics with Applications, 4th edition, by Epp, published by Cengage, ISBN: 9780495391326, Lecture Notes by G. Baker.

Topics List:
Topics for this discrete math course depend on future discussions with colleagues in Management Information Systems.

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

Mathematics 2415 | **3 credits** | **Ordinary and Partial Differential Equations**
Au, Sp, Su

Catalog Description:
Ordinary and partial differential equations: Fourier series, boundary and initial value problems.

Prerequisite:
2153, 2162.xx, 2173, 2182H, 4182H, both (1172 or 1544 or 154) **and** 2568, 254.xx, 263.xx, 263.01H, or 264H.

Exclusions:
Not open to students with credit for Math 2255, 5520H, 2174, 255, 415.xx, or 521H.

Textbook:
Elementary Differential Equations and Boundary Value Problems, 10th Edition, by W. Boyce and R. DiPrima, ISBN 978-1-118-15738-1
-or- Lectures Notes, by Greg Baker, published by Zip Printing.

Topics List:
1.1 Some Basic Mathematical Models & Direction Fields
1.3 Classification of Differential Equations
1.2 Solutions to some Differential Equations
2.2 Separable Equations
2.1 Linear Equations with Variable Coefficients
2.3 Modeling with First Order Differential Equations
2.4 Difference between Linear and Nonlinear Equations
2.5 Autonomous Equations and Population Dynamics
3.1 Homogeneous Equations with Constant Coefficients;
3.3 Complex Roots of the Characteristic Equation
3.4 Repeated Roots

Midterm 1

3.2 Solutions of Linear Homogeneous Equations; the Wronskian
3.4 Reduction of Order
4.5 Non-homogeneous Equations; Method of Undetermined Coefficients
3.7 Mechanical and Electrical vibrations
3.9 Forced Vibrations
10.1 Two-point Boundary Value Problem

Midterm 2

10.2 Fourier Series
10.3 The Fourier Convergence Theorem
10.4 Even and Odd Functions
10.5 Separation of Variables; Heat Conduction in a Rod
10.7 Wave Equation: Vibrations of an Elastic String
7.1 Introduction
7.3 Systems of Linear Algebraic Equations; Linear Independence, Eigenvalues, Eigenvectors
7.5 Homogeneous Linear Systems with Constant Coefficients
7.6 Complex Eigenvalues
7.4 Basic Theory of Systems of 1st Order Linear Equations

Mathematics 2568 **3 credits** **Linear Algebra**
Au, Sp, Su

Catalog Description:
Matrix algebra, vector spaces and linear maps, bases and dimension, eigenvalues and eigenvectors, applications.

Prerequisite:
C- or above in 1172, 1544, 2153, 2162.xx, 2182H, or 4182H; or C- or above in both 1152 and CSE 2321; or credit for 154, 254.xx, 263.xx, 263.01H, or 264H.

Exclusions:
Not open to students with credit for 4568 (568), 5520H (520H), or 572.

Text:
Introduction to Linear Algebra, 5th edition, by L.W. Johnson, R.D. Riess, and J.T. Arnold, published by Pearson, ISBN Softcover: 0321628217, Hardcover: 0201658593

Topics List:

Part I

1.1 Introduction to Matrices and Systems of linear equations
1.2 Echelon Form and Gaussian-Jordan Elimination
1.3 Consistent Systems of linear Equations
1.5 Matrix Operations
1.6 Algebraic Properties of Matrix operations
1.7 Linear Independence and Nonsingular Matrices
1.9 Matrix Inverses and Their Properties
Midterm 1

Part II

2.1 Vectors in The Plane (Review only because it was done in 1152)
2.2 Vectors in Space (Review only because it was done in 1152)
2.3 The Dot Product and The Cross
3.1 Introduction
3.2 Vector Space Properties of R^n
3.3 Examples of Subspaces
3.4 Bases for Subspaces
3.5 Dimension
5.2 Vector Spaces
5.3 Subspaces
5.4 Linear Independence, Bases, and Coordinates
3.6 Orthogonal Bases for Subspaces
3.7 Linear Transformation from R^n to R^m
Midterm 2

Part III

4.1 The Eigenvalue Problem for 2x2 Matrices
4.2 Determinants and the Eigenvalue Problem
4.4 Eigenvalues and Characteristic Polynomial
4.5 Eigenvectors and Eigenspaces
4.6 Complex Eigenvalues and Eigenvectors
4.7 Similarity Transformations and Diagonalization
Final

Mathematics 3345 **3 credits** **Foundations of Higher Mathematics**
Au, Sp

Catalog Description:
Introduction to logic, proof techniques, set theory, number theory, real numbers.

Prerequisite:
Major or minor in Math, CSE, or CIS.

Math: C- or better in 2153, 2162.xx, 2173, or 2182H; or credit for 254.xx, 263.xx or 263.01H.

CIS or CSE:
C- or better in both CSE 2321 and: C- or better in 1152, 1161.xx, 1172, 1181H, 1534, or 1544; or credit for 153.xx, 154, 162.xx, or 162.01H.

Exclusions:
Not open to students with credit for 345.

Text:
Lecture Notes, by N. Falkner.

Topics List:
1. Propositional calculus; quantifiers.
2. Simple examples of mathematical proofs.
3. Mathematical induction.
4. Sets and functions: surjections, injections, bijections.
5. Infinite sets: countable and uncountable.

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

Mathematics 3350 **3 credits** **Introduction to Mathematical Biology**
Sp

Catalog Description:
Introduction to quantitative and qualitative analysis of several mathematical models for biological systems.

Purpose:
This course provides students with experience and knowledge in mathematical analysis of differential equations models, as well as with numerical tools for simulating those models.

Prerequisite:
C- or better in Math 2255, 2415, 5520H; or credit for 255, 415.xx, or 521H.

Text:
Lecture Notes

Topics List:
1. Population dynamics: Logistic growth.
2. Population dynamics: Lotka-Volterra predator-prey model.
3. Modeling specific diseases (e.g. HIV, cancer).
4. Competition models.
5. Dynamics of neurons.
6. Bifurcution theory.
7. Enzyme kinetics.
8. Cells proliferation and death.

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

Mathematics 3532 **3 credits** **Mathematical Foundations of Actuarial Science**
Sp

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

Prerequisite:
C- or better in Math 4530, 5530H, or Stat 4201; or credit for 530, 531H, or Stat 420.

Topics List:
1. Random variables.
2. Discrete distributions.
3. Continuous distributions.
4. Central Limit Theorem and law of large numbers.
5. Risk models.

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

Mathematics 3588 **3 credits** **Practicum in Actuarial Science**
Sp

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

Prerequisite:
3rd year standing and completion of second writing course.

Exclusions:
Open only to actuarial science majors.

Text:
None.

Topics List:
1. Business communication.
2. Problems in life insurance.
3. Problems in property and casualty insurance.
4. Problems in pension consulting.
5. Problems in health care consulting.
6. Risk management.

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

Mathematics 3589 **3 credits** **Introduction to Financial Mathematics**
Au

Catalog Description:
Introduction to mathematics used in financial asset pricing, based on the binomial asset pricing model. This course prepares students for further study of stochastic calculus in continuous time.

Purpose:
This course is designed as an introduction to the concepts encountered in financial mathematics for students who don't have a background in continuous-time stochastic calculus.

Prerequisite:
{C- or better in 3345 or credit for 345}; and {C- or better in 4530, 5530H, or Stat 4201, or credit for 530, 531H, 345 or Stat 420}; or permission of department.

Text:
Stochastic Calculus for Finance I, The Binomial Asset Pricing Model, by Shreve, published by Springer, ISBN: 9780387249681

Topics List:
1. First principles; assumptions about stock behavior and description of basic financial instruments; put and call options.
2. Arbitrage, and no-arbitrage pricing.
3. One-period and multi-period models; replication and hedging.
4. Conditional expectations.
5. Martingales and Markov processes.
6. Change of measure.
7. Utility functions and the capital asset pricing model.
8. Stopping times and American derivatives.
9. Random walks and passage times.

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

Mathematics 3607 **3 credits** **Beginning Scientific Computing**
Au, Sp

Catalog Description:
Introduction to uses of computers to solve problems arising in the physical and biological sciences, and in engineering and finance.

Prerequisite:
{C- or better in 2255, 2415, or 5520H; and C- or better in 2568 or 5520H}; or:
{credit for 255, 415.xx, or 521H; and credit for 568, 571, or 520H}.

Purpose:
Math 3607 is a course which has three main goals: it introduces students to MATLAB (or improves their knowledge of MATLAB); it uses MATLAB to solve practical problems from various areas of mathematics, physics, engineering, business, and finance; and it presents the numerical analysis needed to use MATLAB effectively. The principle underlying this course is that the way to learn MATLAB and numerical analysis is by doing it, not by reading about it. This course is taught in a computer lab and MATLAB will be used to some extent every class.

Textbook:
Learning MATLAB, Problem Solving, and Numerical Analysis through Examples, by Ed Overman (downloadable e-book).

Topics List:
1. MATLAB as a scalar calculator, round-off errors, debugging.
2. Arrays in MATLAB, probability theory, Markov processes.
3. Graphics in MATLAB, applications of probability theory, histograms.
4. Programming in MATLAB, more probability theory, mathematical biology.
5. Function m-files in MATLAB, more Markov processes, chaos.
6. More about functions, randomness.
7. Solving linear systems of equations.
8. Interpolation and approximation.
9. The solution of nonlinear equations and unconstrained optimization.
10. Numerical differentiation and integration
11. Time-evolution ordinary differential equations, boundary-value ordinary differential equations, stochastic differential equations, examples from many disciplines.
12. Eigenvalues, Fourier series.

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

Mathematics 3618 **3 credits** **Theory of Interest**
Au, Sp, Su

Catalog Description:
Financial transactions involving interest: measurement of interest, force of interest, annuities-certain, introduction to financial derivatives.

Prerequisite:
C- or better in 1152, 2162.xx, 1172, 2182H, 4181H; or credit for 153, 162, 162H, or 191H.

Exclusions: Open only to actuarial science majors and pre-majors, and to math majors.

Text:
Mathematics of Investment & Credit, 5th edition, by Broverman, published by Actex. ISBN: 9781566987677
Derivatives Markets, 2nd edition, by McDonald, published by Pearson, ISBN: 9780321280305

Topics List:
1. Compound and simple rates of interest and discount, force of interest.
2. Annuity certain and annuity due.
3. Mortgage amortizations.
4. Evaluation of bonds.
5. Durations.
6. Asset and liability matching.
7. Introduction to options, futures, and other derivatives.

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

Mathematics 4181H, Au	**5 credits**	**Honors Analysis I**
Mathematics 4182H, Sp	**5 credits**	**Honors Analysis II**

Catalog Description:
4181H and 4182H is an enriched honors sequence introducing students to mathematical underpinnings of calculus. 4181H is the first of the calculus sequence designed to introduce students to the mathematical underpinnings of analysis. 4182H is a continuation with a rigorous treatment of multivariable calculus including gradients, multiple integrals, line and surface integrals, Green's theorem, the divergence theorem, and Stokes' Theorem.

Prerequisite:
4181H: Permission of department.
4182H: B- or better in 4181H, or permission of department.

Purpose of Course:
This two-semester 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. 4181H and 4182H will fulfill the analysis requirement for a Math major. The sequence is taught by faculty members in small sections with considerable teacher-student interaction.

Text:
4181H: *Calculus*, 4th edition, by Spivak, published by Publish or Perish, ISBN: 9780914098918
4182H: *Advanced Calculus*, by Folland, published by Pearson, ISBN: 9780130652652

Topics List:

4181H:
1. Properties of real numbers
2. Mathematical induction
3. Definition of integral
4. Integrals of polynomials and trigonometric functions.
5. Applications
6. Continuity, limits, derivatives and applications
7. Fundamental Theorem of Calculus and integration techniques
8. Taylor series
9. Sequences and series of numbers and functions
10. Uniform convergence
11. Power series
12. If time permits, some differential equations or complex-valued functions.

Mathematics 4181H, Au	**5 credits**	**Honors Analysis I**
Mathematics 4182H, Sp	**5 credits**	**Honors Analysis II**

4182H:

1. Multivariable calculus (vector approach)
2. Gradients
3. Multiple integrals
4. Line and surface integrals
5. Green's Theorem
6. Divergence theorem
7. Stokes' Theorem.

Mathematics 4350 **3 credits** **Quantitative Neuroscience**
Sp

Catalog Description:
Introduction to mathematical modeling and computational analysis of neuronal systems, Hodgkin-Huxley model, dynamical systems methods, neuronal networks, models for neurological disease.

Prerequisite:
Math 1152 (152) or 1157 or permission of instructor.

Text:
Foundations of Mathematical Neuroscience, by G. Bard Ermentrout and David H. Terman

Purpose:
Mathematical models and computational methods have been very useful in understanding biological mechanisms underlying neuronal behavior. The Hodgkin-Huxley model, for example, has formed the basis for our understanding of how action potentials are generated and how they propagate along a nerve axon. More recently, mathematical models have been used to help understand cellular processes responsible for both normal and pathological firing patterns that arise in a wide range of neuronal systems. Examples include models for sleep rhythms, sensory processing, Parkinsonian tremor and working memory.

This course provides a detailed introduction to how mathematical and computational methods have been used to both develop and analyze models that arise in neuroscience. We begin by deriving the Hodgkin---Huxley model and then describe dynamical system methods for analyzing models. After discussing the dynamics of single neurons, we consider neuronal networks and describe how different types of population firing patterns depend on biological details, such as the intrinsic properties of individual neurons and synaptic coupling. We conclude by considering specific systems, including models for sleep rhythms, olfaction, working memory and neurological disease.

Topics List:
1. Overview: Neurons, synapses, neuronal firing patterns
2. Hodgkin-Huxley Model: Resting potential, Nernst equation, Goldman-Hodgkin-Katz equation, Cable equation, action potential
3. Dynamics I: Introduction to differential equations; phase-planes; oscillations
4. Dynamics II: Stability analysis, bifurcation theory, numerical methods
5. Single cell dynamics I: Propagating action potentials; rhythmic behavior
6. Single cell dynamics II: Variety of channels, bursting oscillations; dendrites - multi-compartment models
7. Synapses; Simple networks

8. Networks: Classification of network behavior; synchrony, role of different types of channels and coupling
9. Models for sleep: Sleep/wake cycle, Thalamocortical oscillations
10. Parkinson's disease: Basal ganglia, origin of pathological firing patterns, Deep brain stimulation
11. Olfaction
12. Vision
13. Stroke
14. Presentation of projects

Mathematics 4504 **3 credits** **History of Mathematics**
Sp, Su

Catalog Description:
Development of mathematics from primitive origins to present forms. Topics include: development of arithmetic, algebra, geometry, trigonometry, and calculus.

Prerequisite:
C- or better in 2568, 4507, or 5520H; or credit for 568, 571, 507, 580, or 520H; or permission of department.

Exclusions:
Open only to math majors, or students with graduate standing in Ed T&L. Not open to students with credit for 504.

Text:
Journey through Genius, by William Dunham, published by Wiley, ISBN: 0471500305

Topics List:
1. Development of arithmetic; Babylonian tablets and Egyptian papyri.
2. Development of geometry: Pythagoras, Thales, Euclid, Archimedes, Ptolemy, and non-Euclidean geometry.
3. Development of algebra and calculus.

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

Mathematics 4507 **3 credits** **Geometry**
Au, Sp

Catalog Description:
Topics in Euclidean, spherical, and hyperbolic geometries. Connections to high school mathematics, calculus, and the theory of groups are emphasized.

Prerequisite:
C- or better in 3345 and in C- or better in 2568 or 5520H; or credit for 345, and credit for 568, 571, or 520H; or graduate standing.

Text:
Course notes.

Purpose:
This course treats Euclidean, spherical, and hyperbolic geometry from a unified point of view. Moreover, in this course students essentially write their own "textbook" with the proofs of a majority of the theorems left to the student. With this in mind, we hope to encourage the student to become a "do-er" of mathematics.

Topics List:
1. Neutral geometry.
2. Euclidean geometry.
3. Spherical geometry.
4. Hyperbolic geometry.

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

Mathematics 4512 | **3 credits** | **Partial Differential Equations for Science & Engineering**
Au, Sp, Su

Catalog Description:
Second-order PDEs; boundary value problems; Fourier series; wave, heat and Laplace equations; applications.

Prerequisite:
C- or better in 2173, 2153, 2162.xx, 2182H, or 4182H; or credit for 254.xx, 263.xx, 263.01H, or 264H. Intended for undergraduate and master degree students in Engineering and Science.

Exclusions:
Not open to students with credit for 4557, 512, or 557.
Not open to students with a math major, math minor or actuarial science major.

Purpose of Course:
This course develops problem solving skills with little emphasis on theory. Students should be able to solve the PDE's and ODE's and interpret the solution.

Text:
Partial Differential Equations & Boundary Value Problems, 9th OSU custom edition, by Boyce, published by Wiley, ISBN: 9781119935148

Topics List:

Part I: ODE's via The Laplace Transform (Chapter 6); Euler's and Bessel's Equation (½ of Chapter 5)

6.1 Definition of the Laplace Transform
6.2 Solution of Initial Value Problems
6.3 Step Functions
6.4 Differential Equations with Discontinuous Forcing Functions
6.5 Impulse Functions
6.6 Convolution Integral
5.4 Euler's Equation; Regular Singular Points
5.5 Series Solution near a Singular Point: Part I
5.6 Series Solution near a Singular Point: Part II
5.7 Bessel's Equation

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

Midterm I

Part II: Partial Differential Equations and Fourier Series (Chapter 10)

10.1 The Two-Point Boundary Value Problem
10.2 Fourier Series
10.3 Fourier Convergence Theorem
10.4 Even and Odd Functions
Appendix A Heat Conduction Equation: Motivation via Derivation
10.5 Separation of Variables; Heat Conduction in a Rod
10.6 Other Heat Conduction Problems: Nonhomogeneous, Mixed Boundary Conditions
Appendix B Wave Equation: Motivation via Derivation;
10.7 Vibrations of an Elastic String
10.8 Laplace's Equation: Separation in Cartesian Coordinates Dirichelet vs. Neumann Boundary Conditions
10.8 Separation and Solution in Polar and Cylindrical Coordinates

Midterm II

Part III: Boundary Value Problems (Chapter 11)

11.1 Two-point Boundary Value Problems
11.2 Sturm-Liouville Boundary Value Problems I
11.2 Sturm-Liouville Boundary Value Problems II
11.3 Nonhomogeneous Boundary Value Problems
11.4 Singular Sturm-Liouville Problems
11.5 Bessel Series Expansion: Vibrating Drum
11.6 (If time permits: Series of Orthogonal Functions: Mean Convergence)

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

Mathematics 4530 **3 credits** **Probability**
Au, Sp, Su

Catalog Description:
Combinatorial probability, random variables, independence, expectation, variance.

Purpose:
This is an introductory probability course designed to give students a firm grasp of random variables, where they occur, and how they are used, and to develop the computational tools necessary to work with them.

Prerequisite:
C- or better in 2153, 2162.xx, 2173, 2177, 2182H, 4182H; or credit for 254.xx, 263.xx, 263.01H, or 264H.

Exclusions:
Not open to students with credit for any of 530, 5530H (531H), or Stat 4201 or 420.

Follow-up Courses:
Math 3532 (actuarial science majors), Math 3589 (financial math), Stat 4202.

Text:
Probability, by Pitman, published by Springer, ISBN: 9780387979748

Topics List:

I. Discrete probability.

1. First principles: outcome spaces, basic counting techniques, and partitions.
2. Venn diagrams and the inclusion-exclusion principle.
3. Conditional probability and independence; decision trees and Bayes' Theorem.
4. Discrete random variables; mass and generating functions; joint distributions.
5. Binomial, hypergeometric, geometric, negative binomial, and Poisson variables; applications and relationships.
6. Statistics on discrete variables.

II. Continuous probability

7. First principles: density functions, calculation of probabilities and statistics.
8. Moments and moment-generating functions.
9. Common distributions and their applications; exponential, gamma, uniform, normal.
10. The central limit theorem and normal approximation to the binomial distribution.
11. Relationships between the exponential, gamma, and Poisson distributions.
12. Hazard rates and survival functions.
13. Cumulative distribution functions, percentiles, and change of variables.
14. Joint distribution of continuous variables; independence and marginal distributions; density of a function of two variables

Catalog Description:
Topics in calculus and analysis.

Prerequisites:
Either C- or better in 2153, 2162.xx, 2173, 2182H, or 4182H; or credit for 254, 263.xx, 263.01H, 264H, or equivalent;
-and- C- or better in Math 2568, 5520H, or equivalent.

Exclusions: Entry to this course is restricted to graduate students in Statistics or Biostatistics who have permission from the Departments of Statistics or Biostatistics.

Text:
Introduction to Real Analysis, by William F. Trench, Edition1.03, published by Library of Congress Cataloging-in-Publication Data, ISBN: 0-13-045786-8

Topics List:
1. Limits and continuity of functions.
2. Derivative, mean value theorem, optimization.
3. Sequences and series, uniform convergence, power series, Taylor's theorem.
4. Riemann integral, substitution, bounded variation, limit properties, Rieman-Stieltjes integral.
5. Multivariable functions, directional derivatives, chain rule, Taylor's theorem.
6. Inverse and implicit function theorems, Lagrange multipliers, multiple integrals, Jacobians, differentiation under the integral sign.

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

Mathematics 4547 **3 credits** **Introductory Analysis I**
Au, Sp

Catalog Description:
4547-4548 involves advanced calculus covering: sequences, limits, continuity, differentiation, Riemann integral, sequences and series of functions, Taylor series, and improper integrals.

Prerequisite:
C- or better in 3345; or credit for 345.

Text:
Introduction to Real Analysis, 4rd edition, by Bartle & Sherbert, published by Wiley, ISBN: 9780471433316

Topics List:
1. Sequences and their limits.
2. Bolzano-Weierstrass Theorem and Cauchy's criterion.
3. Convergence and absolute convergence of series. Tests for convergence.
4. Power series.
5. Continuous functions.

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

Mathematics 4548 **3 credits** **Introductory Analysis II**
Au, Sp

Catalog Description:
Continuation of Math 4547.

Prerequisite:
C- or better in 4547, or credit for 548.

Text:
Introduction to Real Analysis, 4th edition, by Bartle & Sherbert, published by Wiley,
ISBN: 9780471433316

Topics List:
1. Uniform continuity.
2. Derivatives.
3. Mean Value Theorem, L'Hˆopital's rule.
4. Taylor series.
5. Riemann integral.
6. Exponential and logarithmic functions.
7. Sequences and series of functions.

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

Mathematics 4551 **3 credits** **Vector Analysis**
Au, Sp

Catalog Description:
Vector operations; Jacobian and change of variables; div, grad and curl; Green's Stokes', and divergence theorems; applications.

Prerequisite:
C- or better in 2153, 2162.xx, 2173, or 2182H; or credit for 254.xx, 263.xx or 263.01H.

Exclusions:
Not open to students with credit for Math 4182H, 264H, 513 or 551.

Text:
Advanced Calculus, 5th edition, by Kaplan, published by Pearson, ISBN: 9780201799378

Topics List:
1. Vector operations, multiple integrals, line and surface integrals.
2. Vector operators: div, grad, and curl.
3. Jacobians and change of variables.
4. Green's Theorem, Stokes theorem.
5. Divergence Theorem.
6. Applications.

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

Mathematics 4552 **3 credits** **Complex Analysis**
Sp

Catalog Description:
Introduction to analytic functions of a complex variable, integral theorems, power series, residues, conformal mapping.

Prerequisite:
C- or better in 2153, 2162.xx, 2173, 2182H, or 4182H; or credit for 254.xx, 263.xx, 263.01H, or 264H.

Exclusions:
Not open to students with credit for Math 5522H, 552 or 514.

Purpose:
This course provides a comprehensive introduction to complex analysis, emphasizing applications that are useful in science and engineering.

Text:
Complex Variables and Applications, 8th edition, by Brown & Churchill, published by McGraw-Hill, ISBN: 0073051942

Topics List:

Complex numbers, polar form (Ch. 1)
Analyticity, Cauchy-Riemann equations (Ch. 2)
Elementary functions (Ch. 3)
Cauchy integral theorem and consequences (Ch. 4)

Midterm 1

Power series (Ch. 5)
Residues and poles (Ch. 6)
Applications of residues (Ch. 7)
Mapping by elementary functions (Ch. 8)
Conformal mapping (Ch. 9)

Midterm 2

Applications of conformal mapping (Ch. 10)
Schwarz-Christoffel transformation (Ch. 11)
Poisson integral, Dirichlet problem (Ch. 12)

Mathematics 4556 **3 credits** **Dynamical Systems**
Au

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

Prerequisite:
C- or better in 2153, 2162.xx, 2173, 2182H, or 4182H; or credit for 254.xx, 263, 263H, or 264H.

Text:
Nonlinear Dynamics and Chaos, Steven H. Strogatz, published by Westview Press, ISBN 9780738204536

Topics List:

1. One-dimensional flows: geometric way of thinking; fixed points and stability; population growth and other applications.
2. Bifurcations in one-dimensional flows: saddle-node, transcritical and pitchfork bifurcations; imperfect bifurcations.
3. Theory: existence; uniqueness; continuous dependence.
4. Phase planes: phase portraits; vector fields; nullclines; fixed points; stability; linearization.
5. Linear systems: classification of linear systems; what does the linear system say about the nonlinear system?
6. Limit cycles; introduction; Poincare-Bendixson theorem; conservative systems.
7. Bifurcations of two-dimensional flows; saddle-node, transcritical, and pitchfork bifurcations; Hopf bifurcation theorem.
8. XPPAUT: phase planes; bifurcations; applications.
9. Global bifurcations: homoclinic orbits; Poincare map; stability of periodic orbits.
10. Singular perturbations: Relaxation oscillator; averaging.
11. Applications: (e.g., Neurons).
12. One-dimensional maps: Logistic map.
13. Smale horseshoe: symbolic dynamics.
14. Applications.

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

Mathematics 4557 **3 credits** **Partial Differential Equations**
Sp

Catalog Description:
First and second-order PDE's; existence and uniqueness, initial and boundary value problems, Fourier series; Green's functions; wave, heat and Laplace equations; nonlinear PDE's; applications.

Prerequisite:
C- or better in 2255, 2415, 4556, or 5520H; or credit for 255, 415.xx, or 521H.

Exclusions:
Not open to students with credit for Math 4512 or 512.

Text:
Partial Differential Equations, an Introduction, 2nd edition, Walter A.Strauss, published by Wiley, ISBN: 0471548685.

Topics List:
1. Definition of a PDE, linearity; solution of first-order linear (transport) equation; modeling with PDEs.
2. Well-posed problems, initial- and boundary conditions; secondorder equations; classification into types; the wave equation.
3. Causality and energy; diffusion equation; diffusion on the whole line.
4. Solution of the wave and diffusion equations on a half-line; diffusion and waves with sources.
5. Separation of variables for the wave equation, Dirichlet, Neumann and Robin conditions.
6. Fourier series; sine and cosine series; orthogonality and general Fourier series; completeness and convergence.
7. Midterm. Gibbs phenomenon.
8. Laplace's equation; maximum principle; rectangular coordinates.
9. Poisson's formula; Laplace's equation in circular coordinates.
10. Green's identities; maximum principle; Dirichlet principle; Green's second identity.
11. Green's functions; symmetry; half-space and sphere.
12. Wave equation in two and three dimensions; energy; causality; Huyghens' principle.
13. Rays and characteristics; relativistic geometry; sources; the diffusion equation.
14. The Schrödinger equation; the hydrogen atom.

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

Mathematics 4568 | **3 credits** | **Linear Algebra for Engineering Graduate Students**
Au, Sp, Su

Catalog Description:
Matrix algebra, vector spaces and linear maps, bases and dimension, eigenvalues and eigenvectors, applications.

Prerequisite:
C- or better in 2153, 2162.xx, 1172, 2182H, or 4182H; or credit for 254, 263.xx, 263.01H or 264H.

Exclusions:
Restricted to graduate students in engineering. No open to students with credit for 2568 (568), 5101 (601), 5520H (520H) or 572.

Text:
Introduction to Linear Algebra, 5th edition, by L.W. Johnson, R.D. Riess, and J.T. Arnold, published by Pearson, ISBN: 9780321628217.

Topics List:

Part I

1.1 Introduction to Matrices and Systems of linear equations
1.2 Echelon Form and Gaussian-Jordan Elimination
1.3 Consistent Systems of linear Equations
1.5 Matrix Operations
1.6 Algebraic Properties of Matrix operations
1.7 Linear Independence and Nonsingular Matrices
1.9 Matrix Inverses and Their Properties

Midterm 1

Part II

2.1 Vectors in The Plane (Review only because it was done in 1152)
2.2 Vectors in Space (Review only because it was done in 1152)
2.3 The Dot Product and The Cross
3.1 Introduction
3.2 Vector Space Properties of R^n
3.3 Examples of Subspaces
3.4 Bases for Subspaces
3.5 Dimension
5.2 Vector Spaces
5.3 Subspaces
5.4 Linear Independence, Bases, and Coordinates
3.6 Orthogonal Bases for Subspaces
3.7 Linear Transformation from R^n to R^m

Midterm 2

Part III

4.1 The Eigenvalue Problem for 2x2 Matrices
4.2 Determinants and the Eigenvalue Problem
4.4 Eigenvalues and Characteristic Polynomial
4.5 Eigenvectors and Eigenspaces
4.6 Complex Eigenvalues and Eigenvectors
4.7 Similarity Transformations and Diagonalization

Final

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

Mathematics 4573 **3 credits** **Elementary Number Theory**
Sp (odd years)

Catalog Description:
Prime numbers, modular arithmetic, Diophantine equations, combinatorial analysis; introduction to concepts of abstract algebra.

Purpose:
To introduce students to some topics in number theory at the upper undergraduate level and make connections to other areas of mathematics, such as combinatorics and abstract algebra.

Prerequisite:
C- or better in 3345 or 4181H; or credit for 345 or 264H.

Exclusions:
Not open to students with credit for Math 5576H, 576H or 573.

Follow-up Courses:
4580-4581; or for students with an honors background, 5590H-5591H

Text:
An Introduction to the Theory of Numbers, 5th edition, by Niven, Zuckerman & Montgomery, published by TBS, ISBN: 9780471625469

Topics List:
1. Prime numbers and factorization
2. Congruences and modular arithmetic; the Euler phi-function ø(n).
3. Fermat's "Little" Theorem. Primitive roots.
4. Quadratic Reciprocity
5. Numerical Functions of number theory; multiplicative functions and Moebius inversion
6. Diophantine equations.
7. Number theory from an algebraic viewpoint; groups, rings and fields.
8. Possible additional topics: continued fractions, Pell's equation, and elliptic curves.

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

Mathematics 4575 **3 credits** **Combinatorial Mathematics**
Sp (even years)

Catalog Description:
Enumerative techniques, combinatorial identities, graph theory, algorithms, error correcting codes

Purpose for the Course:
Combinatorics and discrete mathematics are increasingly important, particularly for their applications in computer science. This course will give a brief overview of this subject.

Prerequisite:
C- or better in 2568 or 5520H; credit for 568, 571, or 520H.

Exclusions:
Not open to students with credit for Math 5529H.

Topics List:
1. Counting principles: factorials, permutations and combinations, binomial coefficients, Stirling numbers, double counting.
2. Combinatorial identities: bijections, binomial theorem, generating functions.
3. Graph theory: bridges of Konigsberg, Eulerian circuits, trees, edge coloring, vertex coloring, planar graphs, Kempe's proof of the 5-color theorem
4. Error correcting codes: sphere packing bound, Hamming codes
5. (Optional.) Algorithms: Djkstra's algorithm for minimum spanning tree, depth first and breadth first algorithms for trees, greedy algorithm for graph coloring.

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

Mathematics 4578 **4 credits** **Discrete Mathematical Models**
Sp

Catalog Description:
Homogeneous and non-homogeneous difference equations of one or several variables, Markov chains, graph theory, network flows.

Prerequisite:
{C- or better in 2568 or 5520H; and C- or better in 4530, 5530H or Stat 420}; or {credit for 568, 571, or 520H; and credit for 530, 531H, or Stat 420}.

Exclusions: Not open to students with credit for 578.

Topics List:
1. Homogenous and non-homogeneous difference equations.
2. Application in finance, genetics, economics.
3. Matrix methods, nonlinear equations, stability, bifurcation, harvesting.
4. Application of Markov chains with absorbing and non-absorbing states, limiting behavior.
5. Graph theoretical algorithms, network flows, applications.
6. Linear/integer programming.

Comment:
This course requires the student to use a programming language chosen by the instructor to complete required course work.

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

Mathematics 4580 **3 credits** **Abstract Algebra I**
Au, Sp

Catalog Description:
4580-4581 includes elementary number theory, group theory, vector spaces and linear transformation, and field theory.

Prerequisite:
{C- or better in 3345, and C- or better in 2568 or 5520H} **or**
{credit for 345; and credit for 568, 571, or 520H}.

Exclusions:
Not open to students with credit for 5590H or 591H.

Purpose:
Math 4580-4581 constitutes a two-semester sequence on abstract algebra, intended to familiarize students with the principal concepts, mode of thinking, and important theorems in this subject area. Considerable emphasis is placed on connections between this material and the traditional topics of high school mathematics - Euclidean geometry, polynomial equations, and trigonometry.

Math 4580 begins with a careful review of topics in elementary number theory. There is a study of number systems along with an introduction to the theory of polynomial equation. Groups are introduced in the context of geometrical symmetry and then applied to the constructability problem for regular polygons.

Text:
Notes on Abstract Algebra, by Ron Solomon (in-house notes).

Topics List:

1. Basic properties of the integers: division algorithm and Euclid's lemma
2. Basic properties of the rational numbers: fractions and decimals
3. Fermat's Little Theorem and the Euler --function
4. Review and Midterm 1
5. Basic properties of polynomials: division algorithm and Euclid's lemma
6. Complex numbers and polynomials of small degree
7. The cubic and quartic equations revisited
8. Cyclotomic polynomials
9. Review and Midterm 2
10. Isometries: Rotations, reflections, and translations
11. Congruence in geometry, and the definition of a group
12. Symmetry groups and dihedral groups
13. Constructible numbers
14. The Method of Monsieur Gauss

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

Mathematics 4581 **3 credits** **Abstract Algebra II**
Au, Sp

Catalog Description:
4580-4581 includes elementary number theory, group theory, vector spaces and linear transformation, and field theory.

Prerequisite:
C- or better in Math 4580; or credit for 581.

Exclusions:
Not open to students with credit for 5591H or 592H.

Purpose:
Math 4580-4581 constitutes a two-semester sequence on abstract algebra, intended to familiarize students with the principal concepts, mode of thinking, and important theorems in this subject area. Considerable emphasis is placed on connections between this material and the traditional topics of high school mathematics - Euclidean geometry, polynomial equations, and trigonometry. Math 4581 deepens the theory of groups and of polynomial equations, culminating in Galois' theory of equations and the classification of finite symmetry groups in R3.

Text:
Notes on Abstract Algebra, by Ron Solomon (in-house notes)

Topics List:
1. Permutation groups, orbits, and Lagrange's Theorem
2. The Orbit Counting Formula
3. Imaginaries and Galois fields
4. Gaussian integers and Fermat's two squares theorem
5. Review and Midterm 1
6. Symmetric polynomials and the Fundamental Theorem of Algebra
7. Nonconstructibility and a Lagrange Theorem for fields
8. Galois' Theory of Equations
9. The Galois Correspondence
10. Review and Midterm 2
11. The isometry group of R2
12. Linear algebra in R3
13. The Platonic solids and their symmetries
14. The finite subgroups of SO(3)

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

Mathematics 5520H **5 credits** **Honors Linear Algebra and Differential Equations**
Au

Catalog Description:
Linear transformations and matrices, spectral theorem, ordinary differential equations, existence and uniqueness theorems, phase space, stability, oscillations.

Prerequisite:
C or better in 4182H or in both 2182H and 3345; or C or better in 264H or in both 263H and 345; or permission of department.

Text:
Linear Algebra: An Introductory Approach, revised 4th edition, by Curtis, published by Springer, ISBN: 9780387909929

Introduction to Ordinary Differential Equations, by Coddington, published by Dover, ISBN: 9780486659428

Topics List:
1. Vector spaces and linear transformations.
2. Systems of equations, determinants.
3. Spectral theorem.
4. Ordinary, linear and nonlinear differential equations.
5. Existence and uniqueness theorems.
6. Phase space, stability, and periodic points.

Mathematics 5522H **5 credits** **Honors Complex Analysis**
Sp

Catalog Description:
Theoretical treatment of complex analysis.

Prerequisite:
C or better in 5520H or permission of department.

Text:
Vary, for example:

- *An Introduction to Complex Function Theory*, by B.P. Palka
- *Elementary Theory of Analytic Functions of One or Several Complex Variables*, by H. Cartan
- *Complex Analysis*, 2nd edition, by Bak-Newman
- *Complex Analysis with Applications*, by Silverman

Topics List:

1. Complex numbers, Riemann's sphere. Complex functions, elementary functions, Möbius transformations.
2. Holomorphic functions, Cauchy-Riemann equations.
3. Line integrals. Cauchy's integration theorem and its consequences.
4. Harmonic functions.
5. Sequences and series of holomorphic functions. Power series, analytic functions.
6. Isolated singularities, meromorphic functions, the calculus of residues.
7. Conformal mappings, the Riemann mapping theorem.
8. Geometric principles.
9. Mittag-Leffler's and Weierstrass's expansions of meromorphic functions.
10. Analytic continuation, Riemann surfaces.
11. Applications to number theory, geometry, physics.

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

Mathematics 5529H **5 credits** **Honors Combinatorics**
Au, of even numbered years

Catalog Description:
Techniques of combinatorial mathematics; connections with geometry, algebra, analysis, and probability.

Prerequisite:
C or better in 4182H, or in both 2182H and 3345; or credit for 264H, or for both 263H and 345; or permission of department.

Text:
Discrete Mathematics, by Lovasz, Pelican & Vestergombi, published by Springer,
ISBN: 9780387955858

Proofs from the Book, 4th edition, by Aigner, Ziegler & Hofmann, published by Springer,
ISBN: 9783642008559

Topics List:
1. Counting principles.
2. Generating functions.
3. Finite fields and applications.
4. Theory of partitions.
5. Famous graphs.
6. Ramsey theory.
7. Permutation groups.

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

Mathematics 5530H **5 credits** **Honors Probability**
Sp, of odd numbered years

Catalog Description:
Theoretical treatment of probability, with applications within and outside mathematics.

Prerequisite:
C or better in 5529H, or permission of department.

Topics List:
1. Historical origins of probability.
2. Diverse ways of sampling, allocation, models.
3. Random variables, expectation, moments.
4. Important distributions.
5. Limit theorems: law of large numbers, central limit theorem.
6. Random walks and Markov chains.
7. Statistical independence in analysis and number theory.

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

Mathematics 5540H **5 credits** **Honors Differential Geometry**
Sp, of even numbered years

Catalog Description:
Geometry of curves and surfaces in 3-dimensional space, curvature, geodesics, Gauss-Bonnet Theorem, Riemannian metrics.

Prerequisite:
C or better in 5520H, or in both 2182H and 2568; or credit for 520H, or in both 263.01H and 568; or permission of department.

Text:
Text vary, for example:

- *Differential Geometry of Curves and Surfaces*, DoCarmo
- *Elements of Differential Geometry*, R. Milman and G. Rarker

Topics List:

1. Geometry of curves; Frenet-Serret equations.
2. Curvature of surfaces, First Fundamental Form, Gauss's Theorema Egregium.
3. Geodesics, exponential map.
4. Isometries, conformal mappings; mapmaking.
5. Gauss-Bonnet Theorem.
6. Riemannian metrics, non-Euclidean geometry.

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

Mathematics 5576H **5 credits** **Honors Number Theory**
Au, of odd numbered years

Catalog Description:
Elementary analytic and algebraic number theory, tracing its unifying role in the development of mathematics through history.

Prerequisite:
C or better in 4182H, or in both 2182H and 3345; or credit for 264H, or for both 263H and 345; or permission of department.

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

Text:
Vary, for example:

- *An Introduction to the Theory of Numbers*, 6th edition, by Hardy, Wright, Heath & Brown, published by Oxford, ISBN: 9780199219865.
- *An Introduction to the Theory of Numbers*, I. Niven, H.S. Zukkerman, H.L. Montgomery
- *Number Theory: An Introduction to Mathematics, Parts A and B*, by William A. Coppel, Springer-Velag.

Topics List:

1. Review of Egyptian and Mesopotamian Mathematics. Greek tradition. Three classical Greek problems (cube doubling, angle trisection, circle quadrature).
2. Famous irrationalities.
3. Continued fractions and applications thereof (quadratic surds, Pell's equation, Diophantine approximations, etc.)
4. More on diophantine approximation. Algebraic numbers. Liouville numbers. A glimpse into the Thue-Siegel-Roth Theorem.
5. Uniform distribution modulo one. Weyl criterion. Some important sequences. Pisot-Vijayaraghavan numbers. Formulation and discussion of Margulis' solution of Oppenheimer's conjecture.
6. Normal numbers. Champernoun's example. Almost every number is normal. Levy-Khinchine Theorem on normality of continued fractions.

7. Infinitude of primes. Euler's identity. Chebyshev's Theorem. Bertrand's Postulate. Dirichlet's Theorem on primes in progressions. Average rate of growth of classical number-theoretical functions.
8. Finite fields. Wedderburn's Theorem. Applications: Latin Squares and Cryptography.
9. Quadratic reciprocity.
10. Pythagorean triangles. Representation of integers as sums of squares. Quaternions, Cayley's octavas. Hurwitz' Theorem. Minkowski's geometry of numbers.
11. *p*-adic numbers, their construction and axiomatic characterization (Ostrowski's Theorem). Minkowski-Hasse principle.
12. Fermat's last theorem. Some easy cases. A glimpse into modern developments (elliptic curves, Mordell-Weil Theorem, etc.).

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

Mathematics 5590H, Au	**5 credits**	**Honors Abstract Algebra I**
Mathematics 5591H, Sp	**5 credits**	**Honors Abstract Algebra II**

Catalog Description:
5590H and 5591H includes elementary number theory, group theory, ring theory, abstract linear algebra, field theory, and Galois theory.

Prerequisite:
5590H: C or better in 5520H or in 520H, or permission of department.
5591H: C or better in 5590H or permission of department.

Text:
Vary, for example:

- *Abstract Algebra*, 3rd edition, by Dummit & Foote, published by Wiley, ISBN: 9780471433349
- *Algebra*, by M. Artin
- *Topics in Algebra*, by I. Herstein

Topics List:

5590H:

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.
4. Commutative rings, factorization theory, Euclidean rings, principal ideal rings, unique factorization domains, Gauss' lemma; illustrations in the integers of quadratic number fields.
5. Modules over commutative rings, submodules, quotients and direct sums; fundamental theorem for modules over principal ideal domains.

5591H:

1. Vector spaces (as a special case of modules); linear maps and matrices, canonical forms, dual spaces.
2. The theory of determinants.
3. Bilinear and quadratic forms; inner product and unitary spaces; principal axis theorem.
4. Fields, algebraic and transcendental (extensions), existence of closure (over countable fields), tests for polynomial irreducibility; normality, separability, field automorphisms.
5. Galois theory, the subgroup-subfield correspondence theorem, group theory interrelations; extensions of finite fields, cyclotomic extensions.
6. Solvable groups and solvability by radicals.

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

Mathematics 5591H **5 credits** **Honors Abstract Algebra II**
Sp

Catalog Description:
Continuation of Math 5590H.

Prerequisite:
C or better in 5590H or in 591H, or permission of department.

Topics List:
1. Modules and vector spaces.
2. Modules over a PID, applications to linear algebra.
3. Finite extensions of fields, minimal polynomials, degree, algebraic numbers.
4. Galois theory and its applications.

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

Mathematics 5630 **3 credits** **Life Contingencies I**
Au

Catalog Description:
This course sequence introduces students to the mathematical theory of contingencies. Includes material from examinations by the Society of Actuaries and the Casualty Actuarial Society.

Prerequisite:
C- or better in 3618 **and** C- or better in 4530, 5530H, or Stat 4201; or credit for 530, 531H, or Stat 420; or permission of department.

Exclusions:
Open only to actuarial science majors.

Text:
Actuarial Mathematics for Life Contingent Risks, by Dickson, Hardy & Waters, published by Cambridge, ISBN: 9780521118255

Topics List:
1. Survival distributions.
2. Individual risk models.
3. Life tables.
4. Topics from life insurance.
5. Life annuities.
6. Benefit premiums.

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

Mathematics 5631 **3 credits** **Life Contingencies II**
Sp

Catalog Description:
Continuation of Math 5630 or 530.

Prerequisite:
C- or better in Math 5630, or credit for 630.

Exclusions:
Open only to actuarial science majors, and to MMS students specializing in Financial Math.

Text:
Actuarial Mathematics for Life Contingent Risks, by Dickson, Hardy & Waters, published by Cambridge, ISBN: 9780521118255.

Topics List:
1. Benefit reserve.
2. Multiple life functions.
3. Multiple decrement models.
4. Random and deterministic survivorship group.
5. Valuation of pension plans.
6. Applications.

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

Mathematics 5632 **3 credits** **Financial Economics**
Au, Sp, Su

Catalog Description:
Introduction to the evaluation of options, futures, and other derivatives, interest models and risk management techniques. Includes material from examinations by the Society of Actuaries and the Casualty Actuarial Society.

Prerequisite:
{C- or better in 3618, or credit for 618, or permission of department} –and– {C- or better in 4530 or Stat 4201 or credit for 530 or Stat 420}.

Exclusions:
Restricted to actuarial science majors, math majors, and students with graduate standing.

Text:
Derivatives Markets, 2nd edition, by McDonald, published by Addison-Wesley,
ISBN: 9780321280305

Topics List:
1. Option relationships.
2. Binomial option pricing.
3. Black-Scholes formula.
4. Market making and delta hedging.
5. Exotic options.
6. Brownian motions and Ito's Lemma.
7. Interest rate models.

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

Mathematics 5633 **3 credits** **Loss Models I**
Au

Catalog Description:
5633-5634 introduces students to the construction and evaluation of actuarial models, with topics covered by examinations of the Society of Actuaries and the Casualty Actuarial Society.

Prerequisite:
{C- or better in 4530, 5530H, Stat 4201, or credit for 530, 531H, or Stat 420}; and {C- or better in Stat 4202 or credit for Stat 421}.

Exclusions:
Open only to actuarial science majors and to MMS students specializing in Financial Math.

Text:
Loss Models: From Data to Decisions, 4th edition, by Klugman, Panjer and Willmot, published by Wiley, ISBN: 9781118315323.

Topics List:
1. Measures of risk.
2. Characteristics of actuarial models.
3. Severity models.
4. Frequency models.
5. Aggregate loss models.

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

Mathematics 5634 **3 credits** **Loss Models II**
Sp

Catalog Description:
Continuation of 5633.

Prerequisite:
C- or better in 5633.

Exclusions:
Open only to actuarial science majors and to MMS students specializing in Financial Math.

Topics List:
1. Estimation of data.
2. Parameter estimation.
3. Model selection.
4. Simulation.
5. Credibility.

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

Mathematics 5756, 5757 **3 credits** **Modern Mathematical**
Au, Sp **Methods in Relativity I, II**

Catalog Description:
Special relativity as moving frames; tensors, exterior algebra and exterior calculus; differentiable manifolds and space time structures; parallel transport, torsion and curvatures, metric compatibility; structure equations of differential geometry.

Prerequisite:
Multivariable differential calculus and linear algebra (e.g. Math 2568 and/or 5101). A physics course (e.g. Physics 133 or higher). No prior knowledge of tensor calculus is assumed. However, we do assume a mature attitude towards mathematics and physics.

Purpose:
Develop from the bottom up the fundamental mathematical concepts and methods responsible for the successes in 20th century physics, mathematics, and theoretical engineering. Thus Math 5756 concretizes these developments in terms of:

a) Special Relativity as the cognitive bridge to 20th century geometry
b) Multilinear algebra as a source of geometrical structures,
c) Linear algebra's marriage to multi-variable calculus
d) differential geometry as a three level hierarchy characterized by its
   - Differential structure
   - Parallel transport structure (a.k.a. covariant derivative)
   - Metric structure
e) The exterior calculus
f) Cartan's two structural equations for the various flavors of differential geometry, and their application to
g) The Cartan-Misner calculus

Text:
a) *Gravitation* by C. W. Misner, K. S. Thorne, and J. A. Wheeler.
b) Selections from *Mathematical Methods of Classical Mechanics* by V.I. Arnold.
c) Selections from *Lecture Notes on Elementary Topology and Geometry* by I. M. Singer.
d) Selections from *Spacetime Physics*, 2nd edition, by E. Taylor and J.A. Wheeler

Mathematics 5756, 5757 **3 credits** **Modern Mathematical**
Au, Sp **Methods in Relativity I, II**

Topics List:

Math 5756 (Autumn):

A rapid course in special relativity: spacetime geometry, event horizons and accelerated frames;

- tensors, metric geometry vs symplectic geometry;
- exterior calculus, Maxwell field equations;
- manifolds, Lie derivatives, and Hamiltonian dynamics in phase space;
- parallel transport, torsion, tensor calculus;
- curvature and Jacobi's equation of geodesic deviation;
- Cartan's two structural equations, metric induced properties, and Cartan-Misner curvature calculus.

Math 5757 (Spring):

- Geodesics: Hamilton-Jacobi theory, the principle of constructive interference;
- stress-energy tensor: hydrodynamics in curved spacetime and Einstein field equations;
- The conservation laws and the Bianch identities mathematized in terms of the "Boundary of a Boundary is zero (@ @ - = 0)" Principle.
- Solutions to the Einstein's field equations: stars, black holes, gravitational collapse, geometry and dynamics of the universe;
- vector harmonics, tensor harmonics, acoustic and gravitational waves in violent relativistic backgrounds.

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

Mathematics 5756, 5757 **3 credits** **Modern Mathematical**
Au, Sp **Methods in Relativity I, II**

Catalog Description:
Special relativity as moving frames; tensors, exterior algebra and exterior calculus; differentiable manifolds and space time structures; parallel transport, torsion and curvatures, metric compatibility; structure equations of differential geometry.

Prerequisite:
Multivariable differential calculus and linear algebra (e.g. Math 2568 and/or 5101). A physics course (e.g. Physics 133 or higher). No prior knowledge of tensor calculus is assumed. However, we do assume a mature attitude towards mathematics and physics.

Purpose:
Develop from the bottom up the fundamental mathematical concepts and methods responsible for the successes in 20th century physics, mathematics, and theoretical engineering. Thus Math 5756 concretizes these developments in terms of:

a) Special Relativity as the cognitive bridge to 20th century geometry
b) Multilinear algebra as a source of geometrical structures,
c) Linear algebra's marriage to multi-variable calculus
d) differential geometry as a three level hierarchy characterized by its
   - Differential structure
   - Parallel transport structure (a.k.a. covariant derivative)
   - Metric structure
e) The exterior calculus
f) Cartan's two structural equations for the various flavors of differential geometry, and their application to
g) The Cartan-Misner calculus

Text:
a) *Gravitation* by C. W. Misner, K. S. Thorne, and J. A. Wheeler.
b) Selections from *Mathematical Methods of Classical Mechanics* by V.I. Arnold.
c) Selections from *Lecture Notes on Elementary Topology and Geometry* by I. M. Singer.
d) Selections from *Spacetime Physics*, 2nd edition, by E. Taylor and J.A. Wheeler

Mathematics 5756, 5757 **3 credits** **Modern Mathematical**
Au, Sp **Methods in Relativity I, II**

Topics List:

Math 5756 (Autumn):

A rapid course in special relativity: spacetime geometry, event horizons and accelerated frames;

- tensors, metric geometry vs symplectic geometry;
- exterior calculus, Maxwell field equations;
- manifolds, Lie derivatives, and Hamiltonian dynamics in phase space;
- parallel transport, torsion, tensor calculus;
- curvature and Jacobi's equation of geodesic deviation;
- Cartan's two structural equations, metric induced properties, and Cartan-Misner curvature calculus.

Math 5757 (Spring):

- Geodesics: Hamilton-Jacobi theory, the principle of constructive interference;
- stress-energy tensor: hydrodynamics in curved spacetime and Einstein field equations;
- The conservation laws and the Bianch identities mathematized in terms of the "Boundary of a Boundary is zero (@ @ - = 0)" Principle.
- Solutions to the Einstein's field equations: stars, black holes, gravitational collapse, geometry and dynamics of the universe;
- vector harmonics, tensor harmonics, acoustic and gravitational waves in violent relativistic backgrounds.