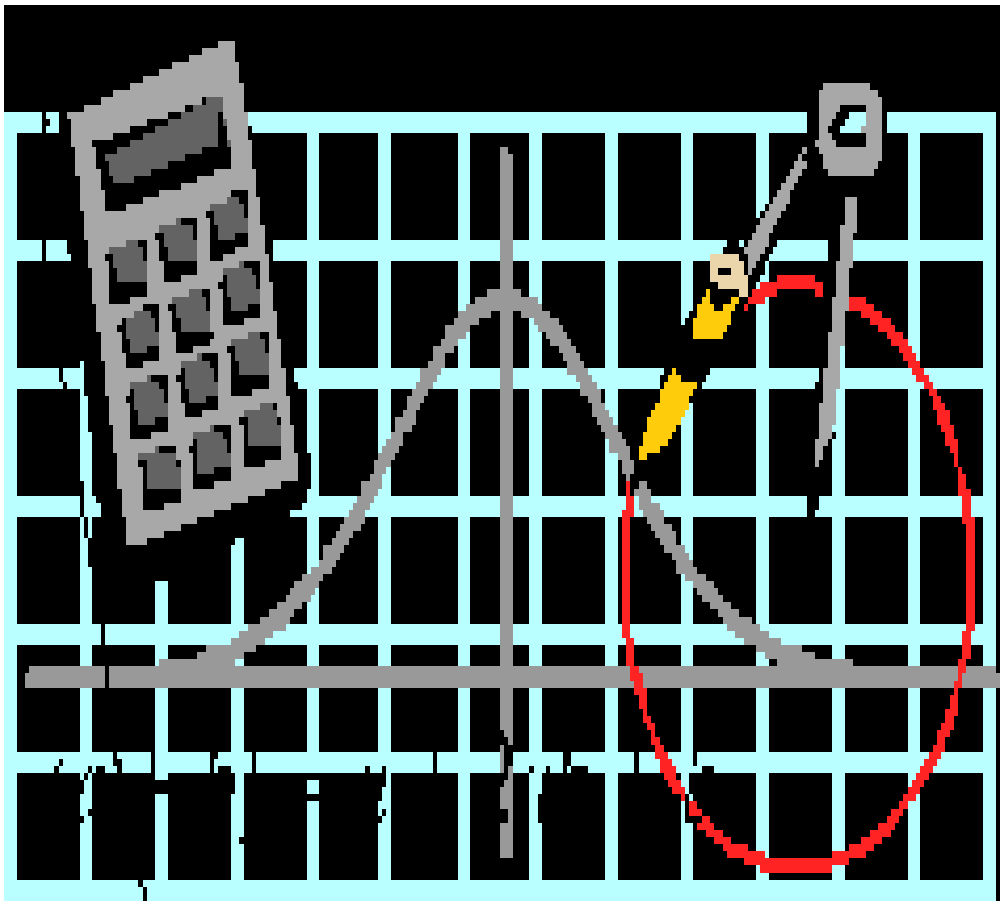
Student Learning Outcomes



Updated December 2014

Course Number and Title: MATH 090: Intermediate Algebra

Credit Hours: 3 (credits may not be used for graduation)

Course Description: This course covers topics from basic algebra, solution of first degree equations and inequalities, graphing of polynomial functions, polynomial functions, polynomial algebra, and solutions to linear systems of equations, exponential and logarithmic expressions.

Student Learning Outcomes:

By completing this course students will be able to:

- Perform operations with integers, fractions, and decimal numbers
- Work with percents
- Solve word problems
- Solve linear equations
- Graph linear equations in two variables
- Solve systems of linear equations
- Work with exponents
- Multiply polynomials
- Factor quadratic polynomials
- Solve quadratic equations

Course Outline:

1. Integers
2. Fractions
3. Decimal Numbers and Percents
4. Problem Solving
5. Introduction to Algebra
6. Linear Equations in One Variable
7. Linear Equations in Two Variables and Graphing Lines
8. Slopes and Equations of Lines
9. Systems of Two Linear Equations
10. Exponents
11. Scientific Notation and Multiplying Polynomials
12. Factoring Quadratic Polynomials
13. Quadratic Equations

Assessments include

- Exam for each of the thirteen chapters
    - Must pass each exam with a 75% or above
    - Can retake the exam until it is passed
- A final exam

Course Number and Title: MATH 100: GE: Numbers, Sets and Structures

Credit Hours: 3

Course Description: This course presents mathematics as a deductive science which starts with empirical observations but goes beyond the level of simple, unrelat4d facts. Search for patterns and, when discovered, justification of them is the essence of this course. Similarities and differences between structures of numbers, sets and some algebraic objects are discussed.

Student Learning Outcomes: During this course, the student should:

- Be able to apply problem solving techniques.
- Understand the uses of sets in mathematics and other disciplines.
- Be able to use truth tables to verify statements.
- Be able to compare different numeration systems.
- Understand and be able to perform calculations using different base systems.
- Use linear equations and linear inequalities to model problems.
- Understand basic counting methods.
- Be able to use basic ideas of probability to find expected values.
- Be able to organize and present data in a statistically meaningful way.

Course Outline: (Selected topics)

1. Problem Solving Techniques
2. Sets
    a. Set Operations
    b. Survey Problems
3. Logic
    a. Inductive and Deductive Reasoning
    b. Statements, Connectives, and Quantifiers
    c. Truth Tables
    d. Conditional and Biconditional
    e. Verifying Arguments
4. Numeration Systems
    a. Place Value Systems
    b. Calculating in other Bases
5. Linear Equations and Systems of Linear Equations
6. Counting Methods
    a. Fundamental Counting Principle
    b. Permutations
    c. Combinations

7. Probability Theory
    a. Compliments and Unions of Events
    b. Conditional Probability and Intersection of Events
    c. Expected Value
8. Organizing and Visualizing Data
    a. Measures of Central Tendency
    b. Measures of Dispersion
    c. The Normal Distribution

Assessments typically include:

- Homework Sets / Projects
- Quizzes: In-class and/or online
- Exams

Course Number and Title: MATH 101: GE: Excursions in Mathematics

Credit Hours: 3

Course Description: This introductory course deals with selected topics in contemporary mathematics applied to the social and natural sciences. Topics include voted and weighed systems, fair division, apportionment, game theory, Euler circuits, the Traveling Salesman Problem, minimum networks, scheduling, linear programming, types of growth, measurement, symmetry and patterns, collecting and describing data, elementary probability and inference**.**

Student Learning Outcomes:

By taking the course, the student will:

- Experience some of the contemporary topics in mathematics.
- Enhance his/her analytical ability.
- Use mathematics to analyze the fairness of social issues.
- Use algorithms to solve problems
- Recognize geometric relationships
- Explore and analyze data.

Course Outline: (Selected topics)

A. Mathematics of Social Choice
    1. Voting and Weighted Voting Systems
    2. Fair Division and Apportionment
    3. Game Theory
B. Management Science
    1. Circuits and Networks
    2. Scheduling
    3. Linear Programming
C. Growth and Symmetry
    1. Types of Growth
    2. Types of Symmetry
    3. Measurement
D. Statistics
    1. Collecting Data
    2. Describing Data
    3. Elementary Probability

Assessments typically include:

- Homework Sets / Projects
- Quizzes: In-class and/or online
- Exams

Course Number and Title: MATH 105: Mathematical Problem Solving for Pre-K to Grade 8 Education Majors

Credit Hours: 3

Course Description: This course is designed to give Pre-K to grade 8 Education majors experiences in being independent solvers of mathematics problems while giving them the mathematical foundation for early mathematics. Concepts in elementary education including sets, whole, integer, ration and real numbers are covered**.**

Student Learning Outcomes:

Students who successfully complete this course should be able to:

- Solve problems using a variety of strategies.
- Estimate solutions of problems with whole numbers, integers, rational, and real numbers.
- Choose an appropriate solution method for problems.
- Discuss the appropriateness of various algorithms for computing with whole numbers, integers, rational, real and complex numbers.
- Use a calculator to solve problems and discuss the appropriateness of calculator solution methods.

Course Outline:

A. Problem Solving
    1. The Problem-Solving Process
    2. Estimation/Mental Mathematics
    3. Using Calculators and Computers in Problem Solving

B. Sets, Relations and Functions
    1. Sets and Operations on Sets
    2. Functions
    3. Relations

C. Whole Numbers
    1. What is a Whole Number?
    2. Writing Whole Numbers
    3. Algorithms for Whole Numbers

D. The Integers
    1. What is an Integer?
    2. Interpreting Integers
    3. Algorithms for Integers.

E. Number Theory
    1. Primes and Composites
    2. Greatest Common Divisors
    3. Least Common Multiple

F. The Rational Numbers
    1. What is a Rational Number?
        i. Algorithms for Decimals, Common Fractions and Percents
    2. Ordering Rational Numbers
    3. Approximating Rational Numbers by Decimals

G. The Real and Complex Numbers
    1. What is a real number?
    2. Rational and Irrational Numbers

Assessments typically include

- Homework and quizzes which may be on-line
- In-class problem solving
- Exams
- A final exam

Course Number and Title: MATH 110: GE: General Statistics

Credit Hours: 3

Course Description: This course deals with the collection and presentation of data, frequency distributions, measures of central tendency and dispersion, elementary probability, randomness, expectations, significance testing on large and small samples, correlation, regression, introduction to analysis of variance and other common statistical methods.

Student Learning Outcomes

Statistics is the science of reasoning from data. The study of statistics is supposed to help students work with data in their everyday life, varied academic disciplines and in their later employment. A first course in statistics introduces many skills, from making a stemplot and calculating a correlation to choosing and carrying out a significance test. This course will focus on understanding statistical concepts and reasoning; organizing, interpreting and producing data; analyzing statistical statements and arguments, and communicating results clearly. After completing the course students will demonstrate the ability to:

• Construct and interpret visual data displays, including bar graphs, pie charts, stemplots, histograms, boxplots, and scatterplots.

• Summarize distributions with numerical measures such as mean, median, standard deviation, range and interquartile range.

• Describe relationships with least-squares regression (LSR) equations and applying the LSR concepts to a variety of real-life data. Use regression models for prediction and calculate least-squares regression equations in Excel.

• Explain how a sample is representative of a population and choosing population parameters that reflect quantities of interest. Demonstrate the difference between the population distribution and the sampling distribution, and use the latter to calculate statistical inferences. Use experimental design to reduce variability.

• Know general probability rules; be able to work with 2 x2 tables and use them to calculate conditional probabilities. Analyze normal and binomial probability models; use random tables to represent populations and simulate random samples using Excel.

• Construct confidence intervals and tests of significance on a population mean and the difference of two means. Construct confidence intervals and tests of significance on a population proportion and the difference of two proportions. Construct a test of significance on two standard deviations.

- Test hypotheses on parameters of a simple linear regression model.
- Make correct interpretation and conclusions for confidence intervals and test of significance

Course Outline:

1. Organizing Data, Frequency Distributions and Histograms
2. Measures of Central Tendency
3. Measures of Dispersion
4. Probability and Probability Distributions
5. Binomial Distribution
6. Normal Distribution
7. Sampling Distributions and Central Limit Theorem
8. Confidence Intervals
9. Hypothesis Testing - One and Two Samples
10. Linear Regression and Correlation
11. Analysis of Variance
12. Goodness of Fit and Independence

Assessments typically include:

- Homework Sets
- Quizzes: In-class and/or online
- Optional Research Projects
- Exams
- Cumulative Final Exam

Course Number and Title: MATH 130: GE: Applied Algebraic Methods

Credit Hours: 3

Course Description: This course introduces students to mathematical modeling using linear, exponential, and power functions and systems of equations. Algebraic and geometric techniques are developed. Applications to the life, social, and management sciences include linear programming and difference equations.

Student Learning Outcomes:

By completing this course, students will

- be able to recognize linear, quadratic, exponential, and logarithmic functions;
- understand the properties of linear, quadratic, exponential, and logarithmic functions;
- be able to translate a function represented symbolically, graphically, numerically, or verbally to another representation;
- be able to determine which function representation will be most useful in answering a specific question;
- have gained experience in using functions to solve applied problems;
- be prepared for further study in mathematics and science.

Course Outline:

The Study of Functions

1. Linear Functions
2. Power Functions
3. Exponential Functions
4. Inequalities and Absolute Value
5. Composition of Functions
6. Inverse Functions
7. Logarithmic Functions
8. Applications - Supply and Demand Curves, Population Growth

Assessments typically include

- Attendance and Class Participation
- Final Exam
- Graded Homework
- In-Class Assignments
- Papers
- Quizzes
- Required Online Lectures
- Required Readings
- Tests

Course Number and Title: MATH 131: GE: Applied Calculus

Credit Hours: 3

Course Description: A one-semester introduction to the techniques of differential and integral calculus, this course will concentrate on the application of these techniques in the life and social sciences.

Student Learning Outcomes

By completing this course, students will

- Use a problem solving approach to investigate and understand mathematical content;
- Formulate and solve problems from both mathematical and everyday situations;
- Use algebra to describe patterns, relations and functions and to model and solve problems;
- Understand the concepts of limit, continuity, differentiation, integration, and the techniques and applications of calculus; and
- Use calculators in computational and problem solving situations.

Course Outline:

A. Differentiation

1. Definition
2. Basic Rules
3. Chain Rule
4. Higher Order Derivatives
5. Implicit Derivatives

B. Applications of the Derivative

1. Linear Approximations
2. Rates
3. Related Rates
4. Maxima and Minima
5. Curve Sketching
6. Differentials

C. Integration

1. Antidifferentiation
2. The Definite Integral
3. The Fundamental Theorem of Calculus
4. Applications of the Definite Integral

D. Exponential and Logarithmic Functions

1. Derivatives
2. Integrals
3. Separable Differential Equations

Assessments typically include:

- Homework Sets
- Quizzes: In-class and/or online
- Optional Research Projects
- Exams
- Cumulative Final Exam

Course Number and Title: MATH 135: GE: Pre-Calculus

Credit Hours: 3

Course Description: This course is designed to prepare students for calculus. Topics include equations, inequalities, functions and their graphs, polynomial, rational, exponential, logarithmic, and trigonometric functions. Prerequisites: College preparatory mathematics including Algebra 2 and Geometry and an appropriate score on the mathematics placement test. Use of a graphing calculator will be expected.

Course Outcomes: By completing this course, students will

- be able to recognize linear, quadratic, exponential, logarithmic, trigonometric, and rational functions;
- understand the properties of linear, quadratic, exponential, logarithmic, trigonometric, and rational functions;
- be able to translate a function represented symbolically, graphically, numerically, or verbally to another representation;
- be able to determine which function representation will be most useful in answering a specific question;
- have gained experience in using functions to solve applied problems;
- be prepared for further study in mathematics and science, particularly to study Calculus.

Course Outline:

A. Equations and Inequalities

1. Linear Equations
2. Quadratic Equations
3. Polynomial and Rational Equations
4. Exponential Equations
5. Systems of Equations
6. Inequalities
7. Absolute Value

B. Functions

1. Functions and their Graphs
2. Operations on Functions
3. Polynomial Functions
4. Rational Functions
5. Exponential Functions
6. Inverse Functions
7. Logarithmic Functions

C. Trigonometry

1. Angles and Triangles
2. Circles and the Trigonometric Functions
3. Graphs of the Trigonometric Functions
4. Inverse Trigonometric Functions
5. Trigonometric Identities
6. Trigonometric Equations
7. Law of Sine's and Cosines

Course Experiences: The following course experiences will allow the student to achieve the course outcomes. The students will

- solve classical and modern precalculus problems;
- work with a variety of different functions;
- describe functions in a variety of ways;
- solve problem posed in a variety of ways;
- be assigned to work problems on their own on a regular basis

Assessments typically include:

- Homework Sets
- Quizzes: In-class and/or online
- Exams
- Cumulative Final Exam

Course Number and Title: MATH 140: GE: Calculus I

Credit Hours: 4

Course Description: Together with Calculus 2 and Multivariate Calculus, the basic concepts and applications of elementary analysis are covered. Topics include functions, continuity, the derivative and its applications, and an introduction to antiderivatives and the definite integral.

Student Learning Outcomes: By completing this course, the student will be able to:

- Use a problem solving approach to investigate and understand mathematical content;
- Formulate and solve problems from both mathematical and everyday situations;
- Communicate in writing and orally, using both everyday and mathematical language;
- Understand and apply numerical computational and estimation techniques and extend them to algebraic expressions;
- Understand and apply the process of measurement;
- Use geometric concepts and relationships to describe and model mathematical ideas and real-world constructs;
- Use algebra to describe patterns, relations and functions and to model and solve problems;
- Understand the concepts of limit, continuity, differentiation, integration, and the techniques and applications of calculus; and
- Use calculators in computational and problem solving situations.

Course Experiences: The following course experiences will allow the student to achieve the course outcomes. The students will

- solve classical and modern problems in calculus, such as evaluating limits, finding rates of change and areas; problems will be solved numerically, graphically and algebraically;
- approximate solutions of problems in calculus using slopes and the area of rectangles; calculator use will be heavily emphasized in these approximations;
- write solutions of assigned problems, exam questions, and projects, having to write in everyday and mathematical language;
- discuss the concepts of calculus in class, having to speak in everyday and mathematical language;
- interpret the language of mathematics, delivered to them orally and in writing;
- work with the graphs of functions and relations, both by hand and on a calculator; and
- work with real-world data which may have been gathered externally, or gathered in-class by an instrument like the Texas Instruments Calculator Based Lab.

Assessments typically include:

- Homework Sets/Projects
- In-class Quizzes
- In-class presentations of applied problems
- Gateway Exam on Differentiation
- Exams
- Cumulative Final Exam

Course Number and Title: MATH 141: GE: Calculus II

Credit Hours: 4

Course Description: The concept of the integral is developed in detail. Techniques of integration, applications of the integral, and an introduction to differential equations are covered. Also, infinite series of numbers and functions are used to illustrate approximation theory.

Student Learning Outcomes: By completing this course, the student will be able to:

- Use a problem solving approach to investigate and understand mathematical content;
- Formulate and solve problems from both mathematical and everyday situations;
- Communicate in writing and orally, using both everyday and mathematical language;
- Understand and apply numerical computational and estimation techniques and extend them to algebraic expressions;
- Understand and apply the process of measurement;
- Use geometric concepts and relationships to describe and model mathematical ideas and real-world constructs;
- Use algebra to describe patterns, relations and functions and to model and solve problems;
- Understand the concepts of limit, continuity, differentiation, integration, and the techniques and applications of calculus; and
- Use calculators in computational and problem solving situations.

Course Outline:

1. Techniques of integration
    a. Substitution
    b. Integration by Parts
    c. Trigonometric Substitution
    d. Algebraic techniques (partial fractions)
2. Approximating definite integrals and the approximation error
3. Improper Integrals
4. Applications of Interation
    a. Geometry
    b. Physics,
    c. Economics
    d. Probability.
5. Sequences
6. Series
7. Taylor Series
8. Differential equations
9. Functions of several variables
10. Vectors, the dot product, and cross product

Assessments typically include

- Homework and quizzes
- In-class projects
- Gateway exam on integration
- Exams
- A final exam

Course Number and Title: MATH 205: Geometry for Pre-K to Grade 8 Education Majors

Credit Hours: 3

Course Description: This course is designed to give Pre-K to Grade 8 Education majors experiences in being independent solvers of mathematical problems while giving them this mathematical foundation for early mathematics. Topics include probability, geometry and geometric systems.

Student Learning Outcomes:

Students who successfully complete this course should be able to:

1. solve problems in geometry, probability and statistics using a variety of strategies.
2. use the tools of geometry to construct geometric figures.
3. use mathematical reasoning to justify solution of problems and proofs of theorems in geometry.
4. use a calculator or computer to solve problems and discuss the appropriateness of computer and calculator solution methods

Course Outline:

A. Probability
    1. Determining Probabilities
    2. Multistage Experiments
    3. Using Simulations
    4. Permutations & Combinations
    5. Expected Value
B. Statistics
    1. Graphs
    2. Measures of Central Tendency
    3. Measures of Spread
    4. Abuses of Statistics
C. Basic Geometry Notions
    1. Basic Definitions
    2. Polygons
    3. Angles
    4. Three Dimensional Geometry
D. Constructions, Congruence and Similarity
    1. Constructions
    2. Congruence Properties
    3. Circles and Spheres
    4. Similar Figures

E. Motion Geometry
    1. Translations and Rotations
    2. Reflections and Glide Reflections
    3. Size Transformations
    4. Symmetries
    5. Tessellations of the Plane
F. Measurement
    1. Length
    2. Areas
    3. The Pythagorean Theorem
    4. Volume and Surface Area
G. Coordinate Geometry
    1. The Cartesian Plane
    2. Equations of Lines

Assessments typically include

- Homework and quizzes which may be on-line
- In-class problem solving
- Exams
- A final exam

Course Number and Title: MATH 220: Discrete Mathematical Structures

Credit Hours: 3

Course Description: The course introduces some basic concepts in mathematics and basic skills for constructing mathematical proofs which are necessary for the further studies in mathematics or in computer science. Topics covered include logic, sets, various relations, functions, mathematical inductions, structures such as lattices, Boolean algebra's, graphs, groups.

Student Learning Outcomes: By completing this course, the student will be able to:

1) Understand deductive and inductive reasoning, mathematical statements, five logic connectives, sentential logic and quantificational logic.
2) Recognize and apply the basic mathematical notations such as set, subset, empty set, "belong to", quantifiers, matrices, etc.
3) Understand and apply the basic mathematical concepts, their development, and their properties: sets and their operations, Cartesian product of sets, various relations such as reflexive, symmetric, and transitive relations, and specific relations, e.g., partial ordering, linear ordering, equivalence relations (and its partition), various functions such as injection, surjection, bijection, invertible functions.
4) Understand the principle of mathematical induction and apply it to prove some equalities, inequalities, and divisibility properties over positive integers.
5) Understand the constructions of basic mathematical structures, such as lattice, Boolean algebra's, graphs, groups, and fields, and their basic properties.
6) Understand and apply the systemic strategies of mathematical proving, which are necessary for students' further studies, especially in mathematics and computer science.

Course Outline

1. Fundamentals
   1.1. The Speaking and Writing of Mathematics
   1.2. Definitions
   1.3. Theorems
   1.4. Proofs
   1.5. Counterexamples
   1.6. Quantifiers
   1.7. Boolean Algebra
2. Collections
   2.1. Lists and Counting
   2.2. Sets
   2.3. Cartesian Product
   2.4. Factorial
   2.5. Permutations and Combinations
   2.6. Binomial Coefficients
   2.7. Combinatorial Proofs

3. Relations
   3.1. Relations
   3.2. Equivalence Relations
   3.3. Partitions
4. Advanced Proofs
   4.1. Contradiction
   4.2. Smallest Counterexample
   4.3. Induction
   4.4. Recurrence Relations
5. Functions
   5.1. Functions
   5.2. Pigeonhole Principle
   5.3. Composition
   5.4. Injections, Surjections, Bijections, Inverses
   5.5. Permutations, Cycles, Transpositions
   5.6. Big O and Little o
6. Advanced Topics (Optional)
   6.1. Introduction to Probability
   6.2. Introduction to Number Theory
   6.3. Groups
   6.4. Mathematics of Cryptography
   6.5. Graphs

Assessments typically include

- Attendance
- Class Participation
- Final Exam
- Graded Homework
- In-Class Assignments
- Papers
- Quizzes
- Required Online Lectures
- Required Readings
- Tests
- Written Proofs

Course Number and Title: MATH 240: Multivariate Calculus

Credit Hours: 4

Course Description: This course develops calculus of several variables. Topics covered include vectors, functions of many variables and their derivatives and integrals, optimization, parametric curves and surfaces, vector fields, line integrals, and applications.

Student Learning Outcomes:

The students will be able to:

- master the three–dimensional coordinate system, working with vectors, equations of lines, planes, cylinders, and quadric surfaces.
- work comfortably with functions of several variables.
- master the computation of partial derivatives.
- apply differentiation to solve maxima and minima problems for functions of two variables.
- master the computation of double integrals.
- apply double integrals to solve problems related to physics and probability.
- gain an understanding of Green's Theorem.
- be able to apply the techniques and knowledge of single–variable calculus to this class.
- be able to apply technology to help master multivariable Calculus.

Course Experiences: The following course experiences will allow the student to achieve the course outcomes. The students will

- solve classical and modern problems in calculus, such as evaluating partial and directional derivatives, finding tangent planes, optimization, evaluating integrals in many variables, finding areas and volumes, and working with vectors and vector fields; problems will be solved numerically, graphically and algebraically;
- approximate solutions of problems in calculus using numerical methods; calculator and computer use will be heavily emphasized in these approximations;
- write solutions of assigned problems, exam questions, and projects, having to write in everyday and mathematical language;
- discuss the concepts of calculus in class, having to speak in everyday and mathematical language;
- interpret the language of mathematics, delivered to them orally and in writing;
- work with the three dimensional and contour graphs of functions and relations, by hand and especially on a computer; and
- work with real-world data which may have been gathered externally, or gathered in-class by an instrument like the Texas Instruments Calculator Based Lab.

Course Outline:

1. Techniques of integration
    a. Substitution
    b. Integration by Parts
    c. Trigonometric Substitution
    d. Algebraic techniques (partial fractions)
2. Approximating definite integrals and the approximation error
3. Improper Integrals
4. Applications of Integration
    a. Geometry
    b. Physics,
    c. Economics
    d. Probability.
5. Sequences
6. Series
7. Taylor Series
8. Differential equations
9. Functions of several variables
10. Vectors, the dot product, and cross product

Assessments typically include

- Attendance
- Class Participation
- Final Exam
- Graded Homework
- In-Class Assignments
- Papers
- Quizzes
- Required Online Lectures
- Required Readings
- Tests

Course Number and Title: MATH 280: Mathematics of Finance

Credit Hours: 3

Course Description: This course consists of an introduction to the theory and mathematics of simple and compound interest with application to and emphasis on annuities, sinking funds, amortization, life insurance, stocks, bonds, and installment buying.

Student Learning Outcomes:

In this course, all students should:

- Be able to solve problems involving simple interest and bank discount.
- Be able to move money along a timeline using simple interest, discount, or compound interest.
- Be able to solve equations of value.
- Work with compound interest.
- Be able to compare and make decisions on different loan terms.
- Be able to create an amortization schedule.
- Understand the different types of annuities: ordinary, deferred, annuities due, and perpetuities.
- Be able to find the value of bonds.
- Be able to calculate different types of depreciation.

Course Outline:

1. Simple Interest and Discount
2. Compound Interest
3. Annuities: Ordinary, Deferred, Annuities Due, Perpetuities
4. Amortization of Debts, Sinking Funds
5. Building and Loan Associations
6. Valuation of Bonds
7. Selected Types of Depreciation

Assessments typically include

- Homework
- In-class projects
- Exams
- A final exam

Course Number and Title: MATH 311: Statistics

Credit Hours: 3

Course Description: This course gives an introduction to Probability theory. Topics include discrete and continuous probability distributions; multivariate probability distributions, conditional and marginal distributions, independence, expectation, and transformations of univariate/multivariate random variables.

Student Learning Outcomes:

In this course, all students should:

1. To understand and be able to apply the basic ideas of probability theory, including probability spaces, disjoint and independent events, conditional probability, random variables, and probability distributions.
2. To be able to use counting techniques such as permutations, combinations, and multinomial coefficients.
3. To recognize, understand and use the common discrete probability distributions, including the Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson, and Multinomial.
4. To be able to develop and use continuous probability models.
5. To be able to recognize and use common continuous probability distributions including the Uniform, Normal, Gamma and Beta.
6. To understand the definition and properties of expectation and to be able to compute the mean and variance of both discrete and continuous random variables.
7. To be able to develop and use bi- and multivariate probability models, and to be able to compute and interpret the associated marginal and conditional distributions.
8. To be able to find distribution of transformations of univariate random variables and multivariate random variables

Course Outline:

1. Introductory Probability

    a. Probability Spaces
    b. Finite Sample Spaces, Permutations and Combinations
    c. Partitions and Multinomial Coefficients
    d. Union and Intersection of Events

2. Conditional Probability

    a. Definition of Conditional Probability
    b. Independence
    c. The Law of Total Probability and Bayes' Rule

3. Random Variables and Their Distributions

a. Random Variables and Discrete Distributions
b. Continuous Distributions
c. The Distribution Function
d. Bivariate Distributions
e. Marginal Distributions
f. Conditional Distributions
g. Multivariate Distributions
h. Distributions of Functions of a Random Variable
i. Distributions of Functions of a Random Vector

4. Expectation

a. Definition of Expectation
b. Properties of Expectation
c. The Mean and Variance
d. Moments and the Moment Generating Function
e. Covariance and Correlation
f. Conditional Expectation

5. Special Distributions

a. The Chebyshev Theorem
b. The Bernoulli and Binomial Distributions
c. The Hypergeometric Distribution
d. The Poisson Distribution
e. The Negative Binomial or Pascal Distribution
f. The Gaussian or Normal Distribution
g. The Gamma Distribution
h. The Beta Distribution
i. The Multinomial Distribution
j. The Bivariate Normal Distribution

Assessments typically include:

- Homework and quizzes
- In-class problem solving
- Exams
- A final exam

Course Number and Title: MATH 320: Linear Algebra

Credit Hours: 3

Course Description: This course deals with the arithmetic of matrices, linear transformation of the plane, algebra of determinants with applications to systems of linear equations, vector spaces, characteristic values and their application.

Student Learning Outcomes

By completing this course, the student will be able to:

1. Determine and describe the solution set to systems of linear equations using matrix techniques and linear algebra theory.
2. Use matrix algebra and determinants to solve problems.
3. Explain in mathematical language and in every day language, the concepts of bases and linear independence to describe vector spaces and subspaces.
4. Explain in mathematical language and in every day language, the geometric connection between solution sets for systems of linear equations and subspaces of R^n.
5. Explain and describe the connection between linear transformation on R^n, functions between abstract vector spaces and geometric transformations.
6. Give at least one example other than R^n of an abstract vector space. Give at least one example of a linear transformation on a space other than R^n.
7. Find solutions to and explain the significance of the eigenvalue / eigenvector problem.
8. Comprehend the complexity and difficulty in finding numerical solutions to matrix problems.

COURSE OUTLINE:

1. Matrices and Linear Systems
   Algebraic Solution for Linear Systems
   Matrix Notation and Operations
   Row Reduction of Matrices and Solution to Linear Systems
   Inverses of Matrices

2. Determinants
   Definition and Computation Schemes
   Properties of Determinants
   Adjoint Matrix

3. Vector Spaces
   Geometric Examples
   Dot Products and Cross Products

Definition and Basic Properties
Subspaces
Linear Dependence and Independence
Bases and Dimension

4. Linear Transformations
   Definition and Basic Properties
   Kernel of a Linear Transformation
   Matrix Associated with a Linear Transformation
   Change of Basis Matrix
   Orthonormal Bases
   Least Squares Approximation

5. Eigenvalues and Eigenvectors
   Definition and Basic Properties
   Computation
   Similar Matrices
   Diagonal Matrices

Assessments typically include:

- Homework Sets
- Quizzes: In-class and/or online
- Exams
- Cumulative Final Exam

Course Number and Title: MATH 341: Differential Equations

Credit Hours: 3

Course Description: This course examines solutions of first-order differential equations, linear equations of higher order, numerical techniques of solution, power series methods, Laplace transformations and applications.

Student Learning Outcomes:

By completing this course, the student will be able to:

1. Using formula solve first order linear differential equations.
2. Solve exact equations, homogeneous nonlinear differential equations.
3. Solve variable separable differential equations.
4. Solve higher order linear differential equations with constant coefficients: homogeneous and non-homogenous.
5. Applying 1-4 to solve some problems in geometry, physics, biological science etc.
6. Using Laplace and inverse Laplace transformations solve differential equations.
7. Solve Cauchy-Euler differential equations.
8. Using power series solve differential equations.

Course Outline

1. Introduction
   1.1. Solutions of Differential Equations
   1.2. Classification of Differential Equations
   1.3. Direction Fields
2. First Order Differential Equations
   2.1. Linear Equations and Integrating Factors
   2.2. Separable Equations
   2.3. Autonomous Equations
   2.4. Exact Equations and Integrating Factors
   2.5. The Existence and Uniqueness Theorem
   2.6. Applications of First Order Equations
3. Second Order Linear Equations
   3.1. Homogeneous Equations with Constant Coefficients
   3.2. Solutions of Linear Homogeneous Equations; the Wronskian
   3.3. Complex Roots of the Characteristic Equation
   3.4. Repeated Roots; Reduction of Order
   3.5. Nonhomogeneous Equations; Method of Undetermined Coefficients
   3.6. Variation of Parameters
   3.7. Applications of Second Order Equations

4. Higher Order Linear Equations
   4.1. General Theory of Higher Order Linear Equations
   4.2. Homogeneous Equations with Constant Coefficients
   4.3. The Method of Undetermined Coefficients
   4.4. The Method of Variation of Parameters
5. Series Solutions of Second Order Linear Equations
   5.1. Review of Power Series
   5.2. Series Solutions Near an Ordinary Point
   5.3. Euler Equations; Regular Singular Points
   5.4. Series Solutions Near a Regular Singular Point
6. The Laplace Transform
   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. The Convolution Integral
7. Numerical Methods
   7.1. The Euler or Tangent Line Method
   7.2. Improvements on the Euler Method
   7.3. The Runge–Kutta Method
   7.4. Multistep Methods

Assessments typically include

- Attendance
- Class Participation
- Final Exam
- Graded Homework
- In-Class Assignments
- Papers
- Quizzes
- Required Online Lectures
- Required Readings
- Tests

Course Number and Title: MATH 351: Modern Geometry

Credit Hours: 3

Course Description: Problem solving in geometry is the main focus of this course. Students will solve problems and write proofs in neutral, Euclidean and non-Euclidean geometries using the properties of axiomatic systems and analytical and transformational approaches to geometry.

Student Learning Outcomes*:* On completion of this course, student will be able to:

- Demonstrate knowledge of axiomatic systems
- Demonstrate knowledge of neutral, Euclidean and non-Euclidean geometries including knowledge of their historical developments
- Write proofs in neutral, Euclidean and non-Euclidean geometries
- Demonstrate knowledge and write proofs in analytical geometry
- Demonstrate knowledge of and write proofs in transformational geometry using congruence, similarity and symmetries
- Demonstrate the ability to do constructions with compass and straight edge and with *Geometers' Sketchpad*

Course Experiences: During this course, students will:

- Read and analyze texts on geometries and axiomatic systems
- Write solutions of assigned problems and exam questions, using correct mathematical and everyday language
- Write proofs and solve problems alone and in groups
- Do constructions with compass and straight edge and with *Geometers' Sketchpad*

Course Outline:

1. Axiomatic Systems
2. Finite Geometries
3. Incidence Geometry
4. Euclid's Geometry and Euclid's *Elements*
5. Hilbert's and Birkhoff's Axioms
6. The SMSG Postulates
7. Neutral Geometry
8. Euclidean Geometry
9. Euclidean Constructions
10. Analytical Geometry
11. Transformations and Isometries
12. Hyperbolic Geometry
13. Elliptic Geometry

Assessments typically include

- Homework and quizzes
- In-class problem solving
- Exams
- A final exam

Course Number and Title: MATH 405: Experimental Design and Sampling for Surveys

Credit Hours: 3

Course Description: This course gives an introduction to survey sampling and experimental design. The topic of survey sampling covers the typical sampling methods, the calculation of estimators of population paramters, and sample size calculations. The topic of experimental design covers the typical methods of design of experiments, ANOVA(analysis of variance) for these design methods, multiple comparisons and contrast analyses. The emphasis will be on applications of the methods of survey sampling and experimental design. The computer package SAS will be required for data analysis.

Student Learning Outcomes:
By completing this course, the student will be able to:

1. Understand the basic concepts in survey sampling, including sample, population, sampling frame and sampling unit, selection bias, and sampling errors.
2. Understand and describe different sampling methods, including simple random sampling, stratified sampling, cluster sampling, systematic sampling, and two-stage sampling.
3. Correctly implement the sampling techniques described in Course Outcome 2 and compute the required sample sizes, the estimates and standard errors.
4. Understand the components in an experimental design, including experimental units, outcome/response variable, explanatory variables, factors, levels of a factor and treatments.
5. Understand and implement completely randomized design (CRD), randomized complete block design (RCBD), Latin-square design, factorial design, and split-plot design.
6. Conduct analysis of variance (ANOVA) for different experimental designs described in Course Outcome 5 using SAS.
7. Conduct multiple comparisons and contrast analyses for different experimental designs described in Course Outcome 5 using SAS.
8. Fit, interpret and check the model assumptions for different experimental designs described in Course Outcome 5 using SAS.
9. Take into account practical considerations of experimental design and select appropriate treatments in practical applications.

Course Outline:

1. Introduction to survey sampling
   a. Basic concepts: population, sample, sampling unit and sampling frame
   b. Questionnaire design
   c. Sampling and non-sampling errors

2. Simple Probability Samples
   a. Simple random sampling, systematic sampling and cluster sampling
   b. Confidence intervals and sample size estimation
   c. Ratio and regression estimation

3. Stratified Sampling
   a. Theory of stratified sampling
   b. Sample size allocation
   c. Model-based inference in stratified sampling
   d. Ratio and regression estimation

4. Cluster Sampling
   a. One-stage cluster sampling
   b. Two-stage cluster sampling
   c. Model-based inference in stratified sampling

5. Experiments with a Single Factor
   a. ANOVA (analysis of variance) for CRD (completely randomized design)
   b. Model adequacy checking
   c. Multiple comparisons and contrasts
   d. Determining the sample size
   e. Regression approach to ANOVA

6. Block Design and Latin-square Design
   a. ANOVA for RCBD (randomized complete block design)
   b. Model adequacy checking
   c. Estimating model parameters and the general regression significance test
   d. Latin-square design
   e. BIBD (balanced incomplete block designs)

7. Factorial Design
   a. Two-factor factorial design
   b. Model adequacy checking
   c. Estimating model parameters and choice of sample size
   d. The 2^k factorial design
   e. Blocking in factorial design

8. Nested and Split-Plot Design
   a. The two-stage nested design
   b. The split-plot design

Assessments typically include:

- Homework and quizzes
- in-class problem solving
- Exams
- research projects using SAS
- final exam.

Course Number and Title: MATH 411: Statistics II

Credit Hours: 3

Course Description: The topics of this statistical inference course include sampling distributions and the central limit theorem, point and interval estimations, properties of point estimators, relative efficiency, consistency, sufficiency, minimum-variance unbiased estimation and two methods or estimation: the method of moments and the method of maximum likelihood, hypothesis testing, analysis of categorical data and linear regression models.

Student Learning Outcomes: By completing this course, the student will be able to:

- Understand the concepts of parameter estimation and various criteria to gauge the estimators.
- Derive the moment estimates for the parameters of various distributions.
- Derive the maximum likelihood estimates for the parameters of various distributions.
- Construct confidence intervals for the parameters of various distributions.
- Understand the concept of statistical hypothesis testing.
- Perform various statistical tests concerning means, proportions and variances.
- Derive the likelihood ratio test statistics.
- Perform statistical tests involving contingency tables and goodness-of-fit.
- Understand the concept of regression analysis.
- Obtain the least squares estimations, and perform the statistical inferences in a simple linear regression and a multiple regression model.
- Use IBM SPSS software package to analyze real-life data.

Course Outline:

1. Sampling Distributions
   a. Sampling distributions related to Normal distribution
   b. The central limit theorem
   c. The Normal approximation to the Binomial distribution

2. Point and Interval Estimations
   a. The bias and mean square error
   b. Unbiased point estimators
   c. Confidence intervals for population means, proportions and variances
   d. Sample size calculations

3. Properties of Point Estimators and Methods of Estimation
   a. Relative efficiency, consistency and sufficiency
   b. Minimum-variance unbiased estimation
   c. The method of moments
   d. The method of maximum likelihood

4. Hypothesis Testing
    a. Elements of hypothesis testing
    b. Hypothesis testing for population means, proportions and variances
    c. Power of tests and Neyman-Pearson Lemma
    d. Likelihood ratio tests

5. Analysis of Categorical Data
    a. Multinomial experiment and multinomial distributions
    b. Goodness-of-fit test
    c. Chi-square test of independence and homogeneity

6. Linear Regression Models
    a. Simple linear regression models and estimation by least squares
    b. Inferences for simple linear regression models
    c. Multiple linear regression models and estimation by least squares
    d. Inferences for multiple linear regression models

Assessments typically include:

• Problems based on the learning objectives will be assigned on a regular basis and may appear in variety of contexts:
• Homework problems serve as both learning and assessment tools for understanding and getting familiar with the topics covered. Working on the homework problems is very important in order to mastering the material.
• Classroom discussion of the problems provides an indication of students' understanding of the topics covered previously. It also can stimulate students' thinking on the new topics.
• Classroom questions are designed to assess the students' ability of theoretical thinking and concept understanding.
• Giving in-class exams is one of the most powerful methods of encouraging students to study the material covered in class. The exams are used to determine whether the students understand the concepts of chance mechanism and other important materials.
• Two research projects will enable the students to explain how statistical techniques they have studied are incorporated in the analytical and numerical analysis of research data and its presentation. The projects will also enable the students to demonstrate their statistical computational skills in IBM SPSS PASW and Excel.

Course Number and Title: MATH 416 / 516: Linear Statistical Modeling Methods with SAS

Credit Hours: 3

Course Description: This course is intended for advanced undergraduate students, graduate students and working professionals who engage in applied research. Statistical linear modeling methods are used in conjunction with SAS computer software to analyze data from experiments and observational studies. Topics include regression analysis, analysis of variance, multiple comparisons and multiple tests, mixed models, analysis of covariance, logistic regression and generalized linear models.

Student Learning Outcomes:
After completing this course, graduate students and advanced undergraduate students will be able to:

● Understand the role of statistics in various fields of scientific investigations. Use statistical methods for analyzing data from experiments and observational studies.
● Use statistical methods that include two-sample procedures, analysis of variance, simple and multiple linear regression, analysis of covariance, and Chi-square tests.
● Test hypotheses and construct confidence intervals for the parameters of linear regression models. Determine the appropriateness of a regression model by analyzing residuals and applying the F test.
● Able to apply some influence diagnostics: Cooks D, Dffits, Dbetas, and collinearity diagnostics: tolerance, variance inflation factor, condition indices, condition number, to remedial simple and multiple regression models. Be able to apply regression transformations, including Box-Cox transformations in SAS.
● Use several selection criteria for "best" regression model selection: the stepwise, forward, and backward methods to select and validate "best "regression model(s)".
● Calculate one- and two-way analysis of variance models and know regression approach to single-factor ANOVA.
● Use SAS/BASE, SAS/Insight, SAS/Analyst, SAS/IML, SAS/Lab, and SAS/Graph packages. Write simple SAS data analysis programs, choose appropriate statistical methods, and communicate statistical results.
● Apply linear statistical methods, diagnostics tools, and remedial measures to novel situations, both theoretically and computationally.
● Use Logistic Regression: Modeling, deviance, residuals (tentative).
● Present research in oral and written form.

Course Outline

Introduction to the SAS System. Review of elementary statistical analysis using SAS/Analyst. Introduction to the SAS Data Step, and procedures PRINT, MEAN and TTEST.

- Introduction to interactive data exploration, straight-line regression and correlation analysis using SAS/Insight and SAS/Graph along with SAS procedures CORR and REG. Inferences in regression and correlation analysis. Prediction of new observation.

- Correlations: Multiple, partial, and multiple-partial correlation. Their representation and interpretation in terms of the regression model.
- Confounding and interaction in regression.
- Diagnostics and remedial measures for single and multiple regression. Regression diagnostics and robustness using SAS/Insight and the procedure REG:
    - Diagnostics for residuals; nonlinearity of regression function; nonconstancy of error terms; nonindependence of error terms.
    - Correlation test for normality.
    - Tests for constancy of variance.
    - Lack of fit F test.
    - Transformations, including Box-Cox transformations in SAS.
    - Influence diagnostics: Cooks D, Dffits, Covratio, Dfbetas
    - Outliers and leverage: the hat matrix diagonal using standardized, studentized and studentized deleted residuals, with predicted values, time and non-modeled regressors. Partial leverage plots and residual normal quantile plots.
    - Extra sum of squares.
    - Collinearity diagnostics: tolerance, variance inflation factor, condition indices, condition number.
- Multiple regression analysis: General considerations of assumptions and the determination of the best estimating equation. SAS procedures REG and GLMMOD.
- Testing hypotheses in multiple regression: Full and reduced models paradigm, partial and sequential sums of squares, and their corresponding *F* tests. Analysis of variance approach.
- Polynomial regression, lack of fit tests and orthogonal polynomials.
- Regression using nominal and indicator (dummy) variables in regression: Comparing straight-line models.
- Analysis of covariance and other methods for adjusting continuous data using SAS procedure GLM.
- Designing simple experiments and studies within Error Rates, Power and Sample Size trade-off relationships.
- Analysis of Variance using SAS/Insight and SAS procedures ANOVA and GLM.
    - One-way analysis of variance, multiple comparisons and multiple testing techniques.
    - Two-way balanced ANOVA and randomized block experiments.
    - Unbalanced ANOVA with multiple factors: Over-parameterization and interpretation using effects, cell means, and reference cell comparisons.
    - Cell means, least square means, contrasts and non-standard test of hypotheses.
- The generalized linear model (GLM): Logit analysis and Poisson regression using SAS/Insight and the SAS procedure GENMOD (tentative.)

Assessments typically include:

Exam, homework assignments, research projects, in-class activities and class discussions. Problem-based learning will be an integral part of the course. Projects and exams for graduate students will be at a higher level of difficulty than for undergraduates.

Course Number and Title: MATH 421: Abstract Algebra

Credit Hours: 3

Course Description: The course will introduce the students to the basic algebraic structures, including groups, rings, and fields.

Student Learning Outcomes:

By completing this course, the student will be able to:

1. Place basic arithmetic and algebra in an abstract setting using some logical number theory and algebraic structures.
2. Understand and apply concepts of number, number theory and number systems
3. Use the standard abstract mathematical tools, namely, definition, example, counter example, theorem and proof.
4. Make and evaluate mathematical conjectures and arguments.

Understand the basic concepts, definitions and structures as described in the course outline.

Course Outline:

Basic Properties of Integers
- Mathematical Induction
- Divisors, Primes and the Division Algorithm
- Common Divisors and Factorization
- Euclidean Algorithm
- Equivalence Relations and Equivalence Classes
- Congruences and the Integers Modulo n.

Basic Properties of Abelian and Non-Abelian Groups
- Definitions and Examples
- Group Tables
- Subgroups
- Cyclic Groups
- Permutation Groups
- Dihedral Groups
- Order of an Element

Cosets and Quotient Groups
- Cosets
- Lagrange's Theorem
- Normal Subgroups
- Quotient Groups

Group Homomorphisms

Definition and Basic Properties
Isomorphism
Isomorphism Theorems
Classification of Cyclic Groups

Introduction to Rings and Fields

Definitions: Ring, Integral Domain, Field
Examples and Basic Properties
Homomorphisms and Isomorphisms
Ideals and Factor Rings
Polynomial Rings
Quotient Fields

Assessments typically include:

- Homework Sets
- In-class Quizzes
- In-class presentations of propositions and proofs
- Two exams
- Cumulative Final Exam

Course Number and Title: MATH 425: Introduction to Mathematical Modeling

Credit Hours: 3

Course Description: Mathematical modeling is the art of using mathematics to understand the world. In this introductory course, we will formulate models using mathematical ideas you already know like proportions and graphing. We will also formulate models using knew mathematical ideas like difference equations and simulations. Emphasis will be on formulating models and using them to draw conclusions. The course will culminate in a service-learning project in which students will work together to develop a model for a client.

Student Learning Outcomes:

By the end of the course students will

- be familiar with several different types of mathematical models;
- understand the importance of assumptions in model building;
- know how to evaluate the effectiveness of a model;
- know how to use a model to draw conclusions;
- have improved their ability to work in groups;
- have improved their technical writing skills.

Course Outline (particular topics subject to change):

1. Formulating Models

   Parts of a Model including Assumptions and Definition of Variables

2. Difference Equations

   Dynamical Systems

   Systems of Difference Equations

3. Proportionality

   Geometric Similarity

4. Fitting Models to Data

   Least-Squares Criterion

   Other Criteria

   Choosing a Best Model

   Simulation

5. Service-Learning Project

Assessments typically include:

- Homework Sets
- An Exam
- Group Projects
- A Service-Learning Project

Course Number and Title: MATH 430: History of Mathematics

Credit Hours: 3

Course Description: This course studies the biographies of leading mathematicians and their contributions to mathematics, the historical development of subject matter-fields of mathematics, and the role that mathematics has played in the development of civilization.

Course Outcomes: By completing the course the student will be able to:

- Understand mathematics in a historical context.
- Understand how mathematics relates to other sciences and other disciplines.
- Understand how mathematics has been influenced by and influenced important developments in diverse cultures.
- Understand how different branches of mathematics are related to each other.
- Understand the contributions to mathematics from nonwestern cultures.
- Understand the major concepts of both Euclidean and non-Euclidean geometries in an historical context.
- Understand and apply the process of measurement.
- Write critically about the relationships within mathematics and between mathematics and other disciplines.
- Understand the significance of axiomatic systems in mathematics.

Course Experiences: The following course experiences will allow the student to achieve the course outcomes. The students will

- Study the lives of important western and nonwestern mathematicians.
- Solve mathematical problems of an historical significance, given in an historical context.
- Discuss how aspects of mathematics have been affected by and have affected various cultures.
- Write about mathematical topics in an historical context.

Assessments typically include:

- Homework
- In-class problem solvig
- Mid-term exam
- Final Exam
- Two papers on mathematicians

Course Number and Title: MATH 431: Teaching Mathematics Using Technology

Credit Hours: 3

Course Description: This course is designed for pre-service and in-service teachers of secondary mathematics. It is a capstone course in both mathematics and the technology used in the mathematics classroom. Students will use various calculators and computer programs to solve significant problems and prepare lessons in calculus, statistics and geometry.

Student Learning Outcomes:

At the end of the course, the participants should be able to:

A. Use graphing calculators, graphing calculator data collection systems, and computer algebra and geometry systems effectively to solve problems in mathematics and statistics

B. Work in a lab setting on a wide-variety of open-ended mathematics problems.

C. Identify and effectively use appropriate technology in mathematics classrooms

D. Write and use in classrooms technology-based curriculum lessons and units.

Course Outline

- Introduction to the history and use of the graphing calculator.
- Introduction to Geometers' Sketchpad
- Introduction to Mathematica
- Use of the graphing calculator in the statistics classroom
- Introduction to the use of the electronic whiteboard
- Methods of evaluating software
- Writing effective technology-rich lesson plans
- Advanced methods of using the graphing calculator

Assessments may include:

- Calculator Evaluation Checklist
- Presenting a statistics lesson
- Evaluating software
- Calculator Use Test
- Technology-rich lesson plan
- Statistics test

Course Number and Title: MATH 445: Mathematics in Modern Technology

Credit Hours: 3

Course Description: This course is designed to introduce the student to some of the contemporary mathematical practices that have been developed tto address problems relating to such technologies as digital image compression, edge detection and signal de-noising. Using appropriate software the students will learn how to model a variety of filters and advanced mathematical transformations and ato apply them to real-life problems.

Student Learning Outcomes:

At the end of the course the students should be able to:

- Name some of the top accomplishments in mathematics during the last 20 years
- Understand the basic concepts of information theory
- Understand the basics concepts of image processing
- Use power series for approximation
- Calculate Fourier series and Fourier transforms.
- Understand and perform operations in the frequency domain
- Understand convolution of sequences
- Construct simple filters
- Construct and use Discrete Haar Transform.
- Construct and use Daubechies filters.
- Construct and use orthogonal and biorthogonal discrete wavelet transforms.
- Implement some wavelet-based methods of image compression, edge detection, and signal de-noising.
- Appreciate the place of mathematics in the real world
- Learn about software packages
- Debug software they have written
- Use computers to help them learn mathematics

Course Outline

1. Spatial Domain Methods
   - Review of Calculus and Probability
   - Gamma Correction and Image Equalization
   - Spatial Domain Filtering and Convolution
   - Edge Detection

2. Frequency Domain Methods
   - Review of Complex Numbers
   - Fourier Series and Convolution
   - Fourier Transforms and Frequency Domain Filtering
   - Image Restoration by Inverse Fourier Filter
   - The Wiener-Helstrom Filter.
3. Wavelet Methods
   - Review of Linear Algebra
   - Elements of Information Theory
   - Haar Wavelet Transform
   - Applications of Haar Wavelet Transform to Compression and Edge Detection
   - Daubechies Wavelet Transformations
   - Biorthogonal Filters and Biorthogonal Wavelet Transforms
   - Image Denoising – VISU-Shrink and SURE-Shrink methods.
   - JPEG 2000

Assessments typically include:

- Homework Sets – theory
- Homework Sets – Matlab programming assignments
- In-class quizzes
- At least eight group projects (Matlab programming).
- In-class presentations of group projects
- Midterm exam
- Cumulative Final Exam

Course Number and Title: MATH 470 / 570: Numerical Methods

Credit Hours: 3

Course Description: This course will develop the numerical algorithms and error estimated for finding roots, solving equations and curve fitting. The emphasis is on algorithms with good error characteristics and reduction of round off error.

Student Learning Outcomes:

On successful completion of this course, students should be able to:

Solve non-linear equations by iteration.
Construct polynomial approximations to functions by interpolation.
Use spline techniques for curve fitting.
Use numerical techniques for differentiation and integration.
Solve ordinary differential equations.
Use MATLAB to implement numerical algorithms.

- Be fluent in the use of Matlab, including an understanding of matrices as the fundamental data-storage unit, array manipulation, control flow, script and function m-files, function handles, graphical output.
- Use Matlab for root-finding, both using user-created and built-in routines.
- Practically implement interpolation and approximation methods in Matlab
- Be able to integrate functions of both one and many variables, paying particular attention to special cases such as interpolating or approximating functions derived from data, both using built-in and user-defined routines.
- Understand stability and error-propagation in numerical methods.
- Use the in-built Matlab ODE solvers appropriately, including an understanding of choice of solver, control of accuracy, event detection.

Course Outline

- **Machine Numbers:** understand IEEE standard binary floating point format, machine precision and computer errors;
- **Bisection Method:** use the bisection method to solve the equation f(x)=0 and estimate the number of iterations in the algorithm to achieve desired accuracy with the given tolerance;
- **One-Point Iteration:** use the iterative method to find the fixed point of the function f(x), and analyze the error of the algorithm after n steps;
- **Higher-order Root finding Methods:** use Newton's method, Newton-Raphson's method, or the secant method to solve the equation f(x)=0 within the given tolerance;
- **Aitken Extrapolation:** understand the order of a convergent sequence and use Aitken's method to accelerate the convergence of the sequence, as well as determining the order of convergence using the iterative method combined with the Taylor formula;

- **Roots of Polynomials:** combine Horner's method with Muller's method to compute roots of a polynomial and analyze whether a numerical root is truly a complex root, or if its imaginary part results from numerical errors.
- **Polynomial Interpolation:** use polynomial interpolations, including the Lagrange polynomial, the Hermit polynomial and cubic spline functions, for curve fitting, or data analysis; use Newton's divided difference or cubic spline algorithms to evaluate the interpolations;
- **Newton Divided Differences:** derive difference formulas to approximate derivatives of functions and use the Lagrange polynomial to estimate the errors of the approximations;
- **Newton-Cotes Integration Methods:** use the closed Newton-Cotes formula, including the Trapezoidal rule and Simpson's rule, to approximate definite integrals; use the Lagrange polynomial to estimate the degree of accuracy; derive the composite numerical integration using the closed Newton-Cotes formula;
- **Richardson Extrapolation:** use Richardson's extrapolation to derive higher order approximation formulas for numerical differentiation and integration;
- **Adaptive Integration Methods:** approximate integrals using adaptive quadrature methods and estimate numerical errors;
- **Programming Skills:** write Matlab programs to solve the above problems.

Assessments typically include:

- Homework Sets – Theory
- Homework Sets – Matlab programming projects
- In-class quizzes
- In-class presentations of computer programs
- Midterm group project
- Midterm exam
- Final group project
- Cumulative Final Exam

Course Number and Title: MATH 480: Operations Research

Credit Hours: 3

Course Description: This course gives an introduction to both determinestic and stochastic operations research. The covered topics will include the nature of operations research, linear programming, project scheduling, dynamic programming, integer programming, queing theory and stochastic simulation.

Student Learning Outcomes:

By the end of the course, the student will:

- be able to recognize problems that can be solved using operations research techniques;
- be able to formulate and solve a linear programming problem and use sensitivity analysis to investigate various scenarios;
- recognize an integer programming problem and know some basic algorithms for solving integer programming problems;
- have a basic understanding of dynamic programming techniques;
- have a basic understanding of queuing theory and the types of queues;
- have an increased appreciation of applied mathematics and the scope of problems that can be solved using mathematics; and
- have increased their mathematical knowledge both by learning new material and by applying known concepts in new situations.

Course Outline:

I. Linear Programming

1. Formulating Linear Programing Problems
2. Graphical Solutions
3. Simplex Algorithm for Maximization Problems
4. Simplex Algorithm for Minimization Problems
5. Recognizing Special Cases: Alternate Optimal Solutions, Unbounded and Infeasible LPs
6. Sensitivity Analysis
7. Duality

II. Optional Topics (Choose among)

8. Critical Path Method and PERT
9. Integer Programming including Branch-and-bound
10. Inventory Models: Deterministic and/or Probabilistic
11. Dynamic Programming: Deterministic and/or Probabilistic
12. Queuing Theory
13. Simulation

Assessments typically include:

- In-class Exercises
- Homework Sets
- Exams
- Group Projects

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