JMU Department of Mathematics and Statistics:
Course Descriptions and Sample Syllabi

Math 103: The Nature of Mathematics

3 credits.

This course is specifically designed for the liberal studies/general education program as an option to the more traditional offerings in mathematics which concentrate in prescribed areas. Flexibility in the choice of content modules provides students a variety of opportunities to experience careful articulation of problems, the powers of abstraction, the use of logic and deduction, and the difference between determinism and probability.

Through the rigorous analysis of carefully selected modules, students develop investigative and communicative skills in mathematics. They broaden their intellectual foundations and critical facilities by seeing examples of what mathematicians seek to do and how they do it. Most importantly, the course seeks to shape attitudes toward mathematics as a worthwhile human endeavor whose benefits can be used and appreciated.

Mathematics is the language of our increasingly technological age. To achieve full realization of potential, all persons need facility in and understanding of this subject. Math 103 helps the liberal studies/general education student meet this need.

Sample Syllabi

1)

(a) Arithmetic, geometry, and problem solving in ancient Egypt and ancient Iraq.

(b) The mathematics of Thales and the Pythagorean school.

(c) The mathematics of Greece in the 4th and 5th centuries BC.

(d) The mathematics of the Hellenistic world with special emphasis on topics that are still in vogue (Pythagorean Theorem, incommensurables, conic sections, etc.).

2)

(a) Permutations and combinations, probability, conditional probability and independence with applications to gambling and the fifteen puzzle.

(b) Cryptography.

(c) Modular arithmetic.

(d) Topics from History of Mathematics.

3)

(a) Axiomatic systems and the field axioms.

(b) First order logic and proof.

(c) First degree equations and systems of first degree equations..

(d) Quadratic equations.

4)

(a) Addition and multiplication of ordered pairs of numbers.

(b) The field "axioms" as theorems in this system.

(c) First degree equations.

(d) Quadratic equations.

Math 107-108: Fundamentals of Mathematics I-II

3 credits each.

Problem solving, conceptual learning, and critical thinking are fundamental to all activities in the discipline of mathematics and are the themes of these courses. Math 107-108 will partially fulfill the requirements for licensure of prospective early childhood, elementary and middle school teachers. They are required courses for students with the Interdisciplinary Liberal Studies major. The subject matter of the courses includes a consideration of several of civilization's greatest achievements, including the real number system, the Hindu-Arabic numeration system, and Euclidean geometry. Conceptual understanding of the four basic operations as they relate to the real number system is emphasized. Problem Solving is stressed throughout each course.

Syllabi

1) Math 107

(a) Numeration systems.

(b) Whole numbers, Integers, Rational numbers, and Real numbers.

(c) Addition and Subtraction with the above sets of numbers.

2) Math 108

(a) Multiplication and division with Whole numbers, Integers, Rational numbers, and Real numbers.

(b) Decimals and Percents.

(c) Ratio and proportion.

(d) Geometry.

(e) Measurement.

Math 135: Elementary Functions

3 credits.

Algebraic, exponential, logarithmic and trigonometric functions are studied as the building blocks of calculus and analysis. Math 135 is designed for freshmen who need to improve their competency in these areas and who plan to take MATH 235 (Analytic Geometry and Calculus, 4 credits). The needs of these students require that the course be highly focused on skills whose applications, values and connections to other disciplines largely will not be realized until later. The liberal studies components which are present in this course are not fully realized until the student completes MATH 235.

Syllabus

(a) Basic algebra.

(b) Functions and their graphs.

(c) Exponential and logarithmic functions.

(d) Trigonometric functions.

(e) Trigonometric identities and equations.

(f) Applications of trigonometry.

(g) The complex number system.

Math 135 will satisfy 3 hours of the B.S. requirement in mathematics. This course does not satisfy the liberal studies requirement in mathematics. The specific objectives of this course are to prepare students to take a follow up course that requires specific basic skills to succeed.

Math 155: Functions and Probability

3 credits. (Math 156: Functions and Probability. 3 credits and 1 hour lab.)

Polynomial, rational and logarithmic functions and applications, systems of equations and inequalities, sequences, counting and probability are studied as the building blocks for calculus and statistics applications to biological, social and management sciences.

Math 155(156) is designed for freshmen who need to improve their competency in these areas and who plan to take Math 205. The needs of these students require that the course be highly focused on skills whose applications, values and connections to other disciplines largely will not be realized until later. The liberal studies components which are present in this course are not fully realized until the student completes Math 205 (Introductory Calculus I, 3 credits).

Syllabus

(a) Review of numbers and their properties, exponents and polynomials, equations and inequalities, coordinates and curves.

(b) Functions and their graphs.

(c) Exponential and logarithmic functions.

(d) Systems of equations and systems of inequalities.

(e) Sequences and counting problems.

(f) Probability and expectation.

Math 155(156) will satisfy 3 hours of the B.S. requirement in mathematics. This course does not satisfy the liberal studies requirement in mathematics. The specific objectives of this course are to prepare students to take a follow up course that requires specific basic skills to succeed. Math 156 differs from Math 155 in that the course meets four hours per week and so the pace of the course is slower.

Math 205-206: Introductory Calculus

3 credits each.

Math 205-206 is a two semester sequence of introductory calculus designed for non-mathematics majors. Calculus is a fundamental area of human knowledge that has greatly influenced our understanding of the world around us. Students have an opportunity in MATH 205-206 to experience an introduction to the concepts of calculus as they apply to disciplines such as the behavioral and life sciences and business. The topics are presented in an informal manner, so the student develops an intuitive grasp of the subject. The opportunities offered in this course of working through optimization, exponential growth and decay, rates of change, and other problems, allow the student to develop rigorous analytical skills and to see in a direct way how mathematicians use mathematics to learn about the real world. The student will appreciate that mathematics is a highly developed language that permits one to communicate effectively in, and better understand, our modern high-technology age.

Syllabi

1) Math 205

(a) Slope of a straight line.

(b) Slope of a curve.

(c) Limits.

(d) Differentiability and continuity.

(e) Rules for differentiation.

(f) Derivative as a rate of change.

(g) Using f' to determine where f is increasing or decreasing.

(h) First and second derivative test.

(i) Curve sketching.

(j) Applications – optimization problems.

(k) Chain rule.

(l) Exponential function and its derivative.

(m) Logarithmic function and its derivative.

(n) Applications of the exponential function.

(o) Antidifferentiation.

(p) The definite integral, $\int_a^b f(x)dx$, as the net change in the antiderivative of f(x).

(q) Applications of the definite integral.

The applications in this course are specifically chosen for behavioral and life sciences and business students. This course is a valuable elective for majors in these disciplines.

2) Math 206

(a) Areas between curves.

(b) Volumes of solids of revolution.

(c) Average value of a function.

(d) Partial derivatives.

(e) Extrema of functions of several variables.

(f) Lagrange multipliers and constrained optimization.

(g) Total differentials and their applications.

(h) Method of least squares.

(i) Double integrals.

(j) Trigonometric functions, their derivatives and applications.

(k) Integration by substitution.

(l) Integration by parts.

(m) Approximation of definite integrals.

(n) Improper integrals.

(o) Differential equations.

The applications in this course are specifically chosen for behavioral and life sciences and business students. This course is a valuable elective for majors in these disciplines. The sequence satisfies the BS requirement in mathematics.

Math 207: Mathematical Problem Solving

3 credits.

Math 207 is a continuation of the study of the mathematical content of Math 107-108 with special emphasis on problem solving strategies, deductive, inductive, and inferential reasoning, probability, and statistics. This is the third required course for students in the Interdisciplinary Liberal Studies program preparing to become early childhood, elementary or middle school teachers.

Syllabus

1. Number Theory.

2. Sets and Counting.

3. Probability.

4. Statistics.

Math 220: Elementary Statistics

3 credits.

This course is designed to expose non-mathematics majors to the basic concepts and methods of statistics most commonly used in a variety of disciplines. The topics covered include graphical and numerical summary of data, correlation and regression, design of experiments, probability, sampling distributions, interval estimation, hypothesis testing, analysis of categorical data, and an introduction to statistical analysis using SPSS.

Employing real-life examples from various areas, the students are led to fully appreciate the intrinsic uncertain aspects of the real world–physical, biological, social, economic, political, and behavioral. The students are taught to read and understand the information given, logically analyze it to make decisions, and clearly express their conclusions. In doing so, the underlying assumptions of the statistical methods and the intrinsic limitations of the conclusions (due to the assumptions imposed and the probabilistic nature) are always emphasized. In particular, the students are taught to distinguish sound statistical procedures and statements from fallacious ones and to guard against the misuse and abuse of statistics. In this manner, the students learn the basic statistical methods used in various disciplines to gain new knowledge and solve problems about the real world and, at the same time, learn to appreciate the limitations of such methods and the knowledge and solutions thus obtained. In addition, the computer component of this course introduces the students to the use of this indispensable tool for analyzing data and solving problems in the modern world.

Statistics is a basic tool for obtaining new knowledge: it is a guide to the unknown. Statistics is widely used not only in the sciences but also in education, business, industry, government, the humanities, and society in general. Humans live in a modern world of constant flux and saturation of information, which can be organized through the use of statistics. Statistics is a subject every educated individual in the modern world can use to make informed decisions. With its emphasis on the basic concepts and methods commonly used in various disciplines, Math 220 is a suitable course for the Liberal Studies Program.

Syllabus

(a) Descriptive Statistics / Introduction to Computers.

1. Displaying and describing data.
2. Measures of central tendency.
3. Measures of variability.
4. Scatterplots.
5. Correlation.
6. Least squares regression.

(b) Designing Experiments and Collecting Data.

1. Steps for designing a study.
2. Observational study, experiments, and causation.
3. Design of experiments.
4. Sampling methods.

(c) Probability.

1. Concepts of probability.
2. Probability rules.

3. Discrete and continuous random variables.

4. Means and variances of random variables.

(d) Sampling Distributions.

1. Normal distributions.

2. Central limit theorem.

3. Introduction to statistical inference.

(e) Statistical Inference.

1. Confidence intervals for population means and proportions.

2. Tests of hypotheses about population means and proportions.

3. Comparison of two population means and proportions.

4. Chi-square tests for categorical data.

5. Use and abuse of tests.

In addition to (a)-(e) above, students enrolled in an "Honors Section" are required to complete a course project. The subject matter of this course has wide application and, thus, this course is an elective for several majors across campus.

Math 231-232: Calculus with Functions

4 credits each.

This is a two semester sequence of courses that integrates Algebra, Precalculus, Calculus I, and part of Calculus II. The algebra and precalculus material provides a resource for students who have entered college with weak mathematical backgrounds, regardless of whether or not they have previously taken high school courses in calculus. The calculus material is presented at the same level as that in Math 235: The concept of a limit is formalized and studied as the basis for the definitions of such concepts as continuity, differentiability, and integrability. The applications of these definitions lead to the development of a collection of theorems that constitute a most powerful arsenal for successful problem solving. The sequence serves as a model for the development of mathematics from theory to application and sets a tone for the future study of mathematics.

Syllabi

1) Math 231

(a) Algebra.

(b) Proofs, including induction.

(c) Limits and continuity, including major theorems.

(d) Derivatives and differentiability, including major theorems.

(e) Power functions with emphasis on graphing and global behavior.

(f) Polynomial functions with emphasis on local behavior and optimization.

(g) Rational functions with emphasis on limiting behaviors.

2) Math 232

(a) Genearal algebraic functions.

(b) Logarithmic and exponential functions.

(c) Trigonometric and inverse trigonometric functions.

(d) The definite integral and Riemann sums.

(e) Indefinite integrals and the Fundamental Theorem of Calculus.

(f) Integration techniques and applications of definite integrals.

Math 231 and Math 232 replace Math 235, which is required in the mathematics major and the mathematics minor.

Math 235, 236, 237: Calculus I, II, III

4 credits each.

This is a three semester sequence of courses that integrates the subject matter of analytic geometry, differential and integral calculus and infinite series. The concept of a limit is formalized and studied as the basis for the definitions of such concepts as continuity, differentiability, integrability and convergence. The applications of these definitions lead to the development of a collection of theorems that constitute a most powerful arsenal for successful problem solving. The sequence serves as a model for the development of mathematics from theory to application and sets a tone for the future study of mathematics.

Calculus is a language used to describe and understand the natural world. In an increasingly technological age, it is essential that educated persons have some understanding of quantitative analysis. The models developed in these courses are important not only in the "obvious" application to the physical sciences, but they are also used with growing regularity in the social sciences.

Syllabi

1) Math 235

(a) Precalculus.

(b) Limits and continuity.

(c) Differentiation.

(d) Optimization and curve sketching.

(e) The definite integral.

(f) The fundamental theorems of calculus.

(g) Applications of the definite integral.

(h) Conics.

This course is a required course for any student wishing to minor in mathematics. The subject matter for this course has wide applications and so this course is a valuable elective for non-specialists.

2) Math 236

(a) Inverse functions.

(b) Logarithmic and exponential functions.

(c) Inverse trigonometric functions.

(d) Techniques of integration.

(e) Polar coordinates.

(f) Indeterminate forms (L'Hopital's rule).

(g) Improper integrals.

(h) Convergence and divergence of sequence and series

(i) Comparison test, ratio test, limit ratio test.

(j) Alternating series, absolute convergence and conditional convergence.

(k) The Taylor remainder theorem and Taylor series.

(l) Power series and Maclaurin's series.

(m) Radius of convergence.

(n) Algebraic properties of power series.

(o) Differentiation and integration of power series.

This course is a required course for any student wishing to minor in mathematics. The subject matter for this course has wide applications and so this course is a valuable elective for non-specialists.

3) Math 237

(a) Vectors

1. Vectors in R2.

2. Vector-valued functions and parametric equations.

3. Vectors in R3.

(b) Curves and surfaces

1. Planes and lines in R3.

2. Cylinders and surfaces of revolution.

3. Quadric surfaces.

4. Space curves.

(c) Multivariate Calculus.

1. Functions, limits and continuity.

2. Partial derivatives and the total differential.

3. The chain rule.

4. The gradient and directional derivatives.

5. Tangent plane and normal line.

6. Extrema and constrained extrema.

7. Implicit functions.

(d) Integration Theory.

1. Double integrals and iterated integrals.

2. Applications of double integrals.

3. Triple integrals.

4. Integration in polar, cylindrical and spherical coordinates.

5. Line and surface integrals.

Math 237 is required in the mathematics major and is required course for any student wishing to minor in mathematics. The subject matter for this course has wide applications and so this course is a valuable elective for non-specialists.

Math 248: Computers and Numerical Algorithms (3,2)

4 credits.

Math 248, as the course name suggests, has a dual focus on computers and algorithms. This is a unique course, in which students will 1) learn structured programming in a high-level programming language (e.g., Fortran90, MatLab, etc.) and 2) use that language to write efficient and well-structured programs to perform a variety of numerical tasks related to applications in the sciences. Course emphasis will be on the algorithms used to solve the problems, rather than the programming language itself. Most people, even those proficient in the daily use of computers, are unaware that computers can sometimes provide inaccurate or erroneous results, even when they are functioning correctly. Consequently, we will spend a good deal of effort identifying sources of error and performing error analyses. When all is said and done, students should not only be able to implement numerical algorithms in well-structured programs, but also be able to argue that their answers are (well, almost) correct!

Syllabus

I. Historical Perspective and Nomenclature

II. Basic Ingredients of Structured Programming

a. Comments, indenting, white space, and clarity

b. Constants and variables; assignment statements

c. Decision structures and loops

d. Basic input/output

e. Vectors and matrices

f. Modular programming and functions/subprograms

III. Machine Representation of Numbers

a. Base conversion

b. Machine storage of integer and floating point

c. Error and its sources

IV. Numerical Algorithms and Error Analysis

a. Pseudocode, algorithm, and program

b. Rootfinding: Fixed-point iteration, Bisection, Newtons Method

c. Numerical Linear Algebra

i. Matrix Multiplication

ii. Gaussian Elimination

iii. Matrix Inverse

d. Polynomial Interpolation

i. Lagranges and Newtons form of the interpolating polynomial

ii. Taylor polynomials

iii. Truncation error and Taylors remainder theorem

e. Numerical Differentiation

i. Two and three-point formulas

ii. Truncation error formulas

iii. Higher order methods

iv. Applications to differential equations (optional)

f. Numerical Integration

i. Right, left, and midpoint rules

ii. Trapezoid rule and Simpsons method

Math 265: Introduction to Fluid Mechanics

4 credits.

Math 265 introduces the student to the application of vector calculus to the description of fluids. The Euler equations, viscosity, dimensional analysis, and the Navier-Stokes equations will be covered among other topics. Because this course is foundational for the interdisciplinary (Physics/Mathematics) computational-science track (for which mathematical modeling, numerical methods, and scientific visualization are the principle skills) more attention will be devoted to the mathematical-modeling aspects of fluid flows than

is customary for, say, introductory fluid mechanics courses for engineers.

The mathematics prerequisite for the course is vector/multivariate calculus, and the physics prerequisite is university physics III, which includes kinematics and dynamics.

PHYS/MATH 265 incorporates both a lecture component (3 hours/week) and a hands-on laboratory component (2 hours/week). Laboratory activities include physical experiments, viewing/discussing classic fluid-motion films, and computer modeling activities.

Syllabus

Part 1: Basic Considerations and Fluid Statics

a) Basic considerations and terminology

b) Fluid statics

Part 2: Fundamentals of Fluid Dynamics

a) Introduction to fluids in motion

b) Integral forms of fundamental laws

c) Differential forms of fundamental laws

d) Dimensional analysis and similitude

e) Reynolds number

Part 3: Incompressible Flow

a) Internal flows

b) External flows

Part 4: Advanced Topics

a) Compressible flow*

b) Flow in open channels*

c) Environmental fluid mechanics*

*time permitting

Math 280: SAS Programming and Data Management

3 credits.

SAS is a comprehensive, widely used statistical programming language for managing, processing, and analyzing data.

In this course students learn the basics of inputting data, combining and manipulating data sets, and describing/analyzing data using elementary statistical techniques. Students also learn how to write SAS programs to perform simulation experiments for illustrating statistical concepts.

The prerequisite for this course is a first course in statistics such as Math 220 or Math 318.

Syllabus

a. Basics

1. The Data Structure in SAS

2. Data and Proc Steps

3. The Data Step

4. Input Statement with list, column, formatted input

5. Proc Print

6. SAS program, log, output, list files

7. Inputting raw data from external files such as Excel

8. Creating permanent SAS data sets

b. Data Management

1. How SAS "Thinks"

2. Sorting with Proc Sort

3. Conditional Processing using IF and ELSE IF statements

4. Performing Iterative Processing: Looping

5. Subsetting and Combining SAS data sets

c. SAS Functions

1. Numeric Functions

2. Character Functions

3. Probability Functions

d. Descriptive Statistics and Graphs

1. Procs Univariate, Means, Freq for one variable summaries

2. Procs Gplot, Corr, Reg for two variables summaries

3. SAS/Insight

e. Using SAS for Basic Inferential Statistics

1. Proc Means for one sample test about a mean

2. Proc Freq for one sample test about a proportion

3. Proc Ttest for two sample test about two means

f. Generating Random Observations and Simulation

1. SAS Distribution Functions

2. Simulation

Math 285: Data Analysis

4 credits.

Concepts of data analysis are developed through a study of experimental and survey design, distributions, variation, chance, sampling variation, computer simulation, bootstrapping, estimation and hypothesis testing using real data generated from classroom experiments and large data bases.

Math 285 provides students a "hands-on," calculus-based, highly computer-oriented approach to the introduction of probability and statistics. The subject matter and approach to the material is particularly suitable for students who have an interest in the interaction of science and statistics.

Syllabus

(a) Describing data with statistical software.

1. Univariate: histogram, stem and leaf, boxplot, mean (derived as least squares estimate of mu) median, percentiles, stdev., etc.

2. Bivariate: scatterplot, correlation, least squares line, association vs. causation.

(b) Producing Data by Sampling.

1. Terms: population, unit, sample, sampling frame, etc.

2. Need for sampling design.

3. Simple random sampling, selections of SRS's.

4. Sampling variability, sampling error, sampling distribution.

5. Stratified random sampling.

(c) Producing Data by Experimentation.

1. Terms: experiment, units, variable, response variable, factor, treatment, design of experiment.

2. Need for experimental design.

3. Basic principles of experimental design: comparison, randomization, replication.

4. Completely randomized design, randomized block design.

(d) Probability - the study of chance.

1. Introduction: random phenomena, probability, probability in statistical inference, basic ideas, applications.

2. Probability model, axioms of probability, equally likely outcomes.

3. Counting principles: multiplication rule, permutations, combinations, partitions.

4. Properties of probability, general addition rule, complements, conditional probability, multiplication rule, independence.

(e) Discrete Random Variables/Populations.

1. Random variables and their distributions.

2. Expected values of random variables and functions of random variables, properties of expectations.

3. Bernoulli populations and random variables.

4. The hypergeometric distribution.

5. The binomial distribution.

(f) Continuous Random Variables/Populations.

1. Continuous random variables and their distributions.

2. Expected values of continuous random variables.

3. The uniform distribution.

4. The exponential distribution.

5. The normal distribution.

(g) Statistics and Sampling Distributions.

1. Sample mean and variance.

2. Sampling distribution of the sample mean.

3. Normal approximation to the binomial distribution.

(h) Estimation.

1. Point estimators and properties.

2. Confidence interval for mean: normal and non-normal populations.

3. Sample sizes for estimating means.

(i) Hypothesis testing.

1. Basic concepts, logic of hypothesis testing, power, p-value, etc.

2. Hypothesis testing about a single mean: normal and non-normal populations.

3. Hypothesis testing about two or more means: analysis of variance, multiple comparison procedures.

Math 285 is designed for applications-oriented students who have an appropriate background.

Math 300: Linear Algebra

3 credits.

An introduction to linear algebra is developed through a study of vector spaces, linear transformations, matrices, determinants, systems of linear equations, eigenvalues and eigenvectors.

Math 300 is designed to begin the process of abstraction and the development of proof. Basic definitions and concepts are introduced and used to establish a basis for the understanding of factual information that is often taken for granted, such as the statement "a system of linear equations either has no solutions, exactly one solution or infinitely many solutions." The subject matter of this course has relevance to almost all applications of mathematics and so this course is a valuable elective for non-mathematics majors who have a calculus background and level of mathematical maturity.

Syllabus

(a) Systems of linear equations and matrices.

(b) Determinants.

(c) Vectors in 2-space and 3-space.

(d) Vector spaces.

(e) Linear Transformations.

(f) Eigenvalues and eigenvectors.

Math 300 is a requirement in the mathematics major, and serves as an elective for any student wishing to minor in mathematics.

Math 304: Principles of Algebra

3 credits.

Math 304 is a basic course covering elementary topics from abstract algebra and linear algebra. It is especially designed for prospective and in-service teachers of Kindergarten through 8^{th} grade. The introduction of proof is an element of this course. Math 304 is an elective course for those students in the Interdisciplinary Liberal Studies program with a math/science concentration. This course counts toward the Algebra I add-on certification for middle school teachers in Virginia.

Syllabus

1. Fundamental concepts-sets, relations, functions, binary operations, and logical terms.

2. Mathematical systems- integers and rational numbers as ordered pairs, integers modulo m, two-by-two matrices, rigid motions of the plane.

3. Groups-definition, examples, elementary properties, permutation groups, subgroups.

4. Rings, integral domains, and fields-examples, elementary theorems.

Math 305: Principles of Geometry

3 credits.

This course offers a variety of geometrical topics which may include taxicab geometry, conic sections, four-dimensional space, trigonometry in the unit circle, the geometry of the sphere, and geometric patterns in art. Math 305 is an elective course for those students in the Interdisciplinary Liberal Studies program with a math/science concentration. The most important objective of this course is to introduce students to mathematical thinking and reasoning through a hands-on exploration of interesting and challenging topics in geometry. The emphasis in this course is on conjecture, exploration, and articulation of geometric ideas, leading to the development of a robust proof or refutation. The goals of this course can be roughly divided into the broad areas of *process goals* (exploration, proof, and communication) and *content goals* (in synthetic, analytic, and transformational geometry).

By the end of the course, the successful student will be able to:

• explore geometric relationships among classes of two- and three-dimensional objects – for example, congruence, parallelism, symmetry,

• discover and verify basic properties of common geometric objects,

• describe and explore spatial relationships using a coordinate system,

• use transformations and symmetry to analyze geometric questions, • use algebraic techniques to analyze geometric questions.

Syllabus

1. Finite geometries.
2. geometric transformations.
3. constructions.
4. geometry of inversion.
5. projective geometry.
6. non-Euclidean geometry.

Math 306: Principles of Analysis

3 credits.

This course covers the concepts of sequences, limits, continuity, differential and integral calculus with an emphasis on the role of calculus in problem solving.

Syllabus

1. Historical perspective
2. Functions
3. The real number
4. Sequences, subsequences, limits
5. Discrete change and linear difference equations
6. Non-linear equations
7. The derivative (motion, rates of change, optimization)
8. The integral (accumulation and area, numerical background, fundamental theorem of calculus)
9. Concepts of differential equations and applications (harmonic motion, exponential growth, dynamical systems)

Math 306 is an elective course for those students in the Interdisciplinary Liberal Studies program with a math/science concentration.

Math 307: Principles of Probability and Statistics

3 credits.

This course covers the Basic concepts of descriptive statistics to include the topics o f probability, simulation, probability distributions, and an introduction to inference. This is an elective course for those students in the Interdisciplinary Liberal Studies program with a math/science concentration.

Syllabus

1. History of statistics overview.

2. Descriptive statistics (histograms, stem and leaf plot, boxplots, etc.; measures of central tendency and dispersion, correlation).

3. Probability (experiments, sample space, basic probability, conditional probability, independence, random variables, expected value).

4. Probability distributions and statistical inference (Counting techniques, binomial distribution, normal distribution, sampling distribution, central limit theorem, applications).

Math 310: Elementary Theory of Numbers

3 credits.

The theory of numbers is developed through a study of the properties of integers and prime numbers, divisibility, congruence, residues and selected topics.

Math 310 is designed to begin the process of abstraction and the development of proof. Basic definitions and concepts are introduced and used to establish a basis for the understanding of factual information that is often taken for granted, such as the statement "an integer is divisible by three if and only if the sum of it's digits is divisible by three." The subject matter of this course is particularly useful to middle and secondary teachers and so this course is a valuable elective for students who wish to become teachers.

Syllabus

(a) Preliminary considerations.

(b) Divisibility theory in the integers.

(c) Primes and their distribution.

(d) The theory of congruences.

(e) Fermat's theorem.

(f) Primitive roots and their indices.

Math 310 is an elective in the mathematics major. This course is an elective in the teacher certification program and serves as an elective for any student wishing to minor in mathematics.

Math 315: The Real Number System

3 credits.

The system of the real numbers is developed through a systematic study of the natural numbers, integers, rationals, and irrationals.

Math 315 is designed to begin the process of abstraction and the development of proof. Basic definitions and concepts are introduced and used to establish a basis for the understanding of factual information that is often taken for granted, such as the two statements "the square root of 2 is not rational," or "between any two distinct numbers there is a rational number." The subject matter of this course is particularly useful to secondary teachers and so this course is a valuable elective for students who wish to become teachers.

Syllabus

(a) Notation, logic, and sets.

(b) Relations.

(c) Binary operations.

(c) The natural number system.

(d) Order and cancellation.

(e) Well-ordering.

(f) One-to-one correspondences and counting.

(g) The integers.

(h) Ordering the integers.

(i) Notation for the integers.

(j) The rational numbers.

(k) Ordering the rational numbers.

(l) Some concluding remarks about the rational numbers.

(m) An intuitive look at the real numbers.

(n) Sequences.

(o) The real numbers.

(p) Order.

(q) Completeness (optional).

(r) Dedekind cuts (optional).

(s) The Peano axioms (Optional).

Math 315 is an elective in the mathematics major. This course is an elective in the teacher certification program and serves as an elective for any student wishing to minor in mathematics.

Math 318: Introduction to Probability and Statistics

4 credits.

The theories of probability and statistics are developed in a course that introduces the student to descriptive statistics, counting, probability, random variables, sampling distributions, estimation, regression and correlation.

Math 318 is a calculus-based course that is required of mathematics and statistics majors. It is a course designed to lead into the applied statistics courses and to the capstone statistics course Math 426-427. This is a course that lays the foundation for the theory of statistics.

Syllabus

(a) Introduction to the nature of probability and statistics.

(b) Probability and counting.

1. Probability measure.

2. Permutations.

3. Combinations.

4. Conditional probability.

5. Independence.

(c) Discrete random variables, distributions and moments.

1. Bernoulli.

2. Binomial.

3. Geometric.

4. Negative binomial.

5. Poisson.

6. Hypergeometric.

(d) Continuous random variables, distributions and moments.

1. Uniform.

2. Exponential.

3. Gamma.

4. Normal.

(e) Multivariate probability distributions.

1. Joint, marginal and conditional.

2. Independence.

3. Expectations.

4. Covariance.

(f) Sampling and statistics.

1. Sampling distributions of the sample mean and sample variance.

2. Central limit theorem.

(g) Point and interval estimation of the population mean (including proportion) and population variance.

(h) Testing the hypothesis involving the normal and related distributions.

Math 321: Analysis of Variance and Experimental Design

3 credits.

Basic concepts in statistics and basic statistical techniques are introduced and reinforced through the study

of applications in statistics. The topics covered include estimation, test of hypothesis, analysis of variance and selected topics in experimental design.

The design of an experiment refers to the choice of treatments and the manner in which experimental units or subjects are assigned to the treatments in a scientific study. Selection of an appropriate design is crucial in avoiding confounding results and minimizing experimental error. Math 321 covers some basic experimental designs with corresponding models and analyses. This course is an important course for a variety of students in the empirical sciences.

Syllabus

(a) Introduction/Review.

1. Inference for a single mean.

2. Inference for a single variance.

3. Inference for two means.

4. Inference for two variances (confidence interval and hypothesis test).

5. Test of normality (Normal plot).

6. Test of outliers (Box plot).

7. Introduction to SAS.

(b) Principles of Design of Experiments.

(c) Oneway ANOVA: fixed effects.

(d) Hierarchical and nested designs.

(e) Two factor ANOVA: fixed effects.

1. Twoway factorial.

2. Randomized complete block design.

(f) Three and four factor ANOVA: fixed effects.

1. Threeway factorial.

2. Latin square design.

3. Graeco-Latin square design.

(g) Variable effects models.

1. Random models.

2. Mixed models.

3. Variance components.

(h) Repeated measures designs.

1. Within subjects ANOVA.

2. Split plot design.

3. Crossover design.

Math 321 has broad application to many disciplines, satisfies the B.S. requirement in statistics, and serves as an elective for the statistics minor.

Math 322: Applied Linear Regression

3 credits.

Basic concepts and methods in regression analysis are studied through the application of linear regression models to real-life situations.

Regression analysis is an area of statistics that deals with methods for quantifying the relationship between a dependent variable and one or more independent variables for the purposes of description and prediction. For example, a college admissions officer might be interested in predicting the gpa of a prospective freshmen based on variables such as high school gpa, rank in class, amount of extracurricular activity, etc. Math 322 covers the basic concepts of regression models and model building. The methodology is widely used in the social and behavioral sciences, the bio/medical sciences, and many other disciplines.

Syllabus

(a) Introduction to regression analysis.

(b) Populations, samples, and probability distributions.

(c) Basic statistical inference.

(d) The simple linear regression model.

(e) Inference in simple linear regression.

1. Sampling distributions of point estimators of regression coefficients

2. Confidence intervals and hypothesis tests for regression coefficients

3. Point estimate and confidence interval for mean response

4. Point prediction and prediction interval for a future observation

(f) The assumptions behind regression analysis.

(g) Multiple regression.

1. Quantitative predictors.

2. Inferences in multiple regression.

3. Qualitative predictors and indicator variables.

4. Multicollinearity.

(h) Model building.

1. Data collection.

2. Model diagnostics and remedial measures.

3. Transformations.

4. Model selection.

Math 324: Applied Nonparametric Statistics

3 credits.

The principles of nonparametric statistics are introduced through a study of the methods used to analyze non-normal populations. The methods include binomial tests, contingency tables, use of ranks, Kolmogorov-Smirnov type statistics and other selected topics.

Assessing the reliability of conclusions drawn from statistical methods involves the selection of an appropriate probability model for the phenomenon under study. Traditionally normal models have been assumed even though the phenomenon under study does not have exactly the normal distribution. Finding probabilities for the true model or a more reasonable model may be difficult. Also the assumption of normality leads to well-studied "parametric" methods such as the "t test" or the "F test". Nonparametric statistical methods do not make the assumption of normality. They are based on reasonable if not exact models whose probabilities can be calculated using simple and unsophisticated methods. This course would be beneficial to students in the biological and social sciences.

Syllabus

(a) One-sample methods

1. Binomial test.

2. Inferences for percentiles and population cumulative distribution function.

(b) Comparison of two treatments.

1. Permutation tests using means and medians.

2. The Wilcoxon rank-sum test.

3. The Mann-Whitney test and confidence interval.

4. The Siegel-Tukey test.

5. The Kolmogorov-Smirnov test.

6. Estimation of treatment effect.

(c) Comparison of more than two treatments.

1. The Kruskal-Wallis test.

2. The Permutation F-test

(d) Paired comparisons.

1. The Wilcoxon signed-rank test.

2. The sign test.

(e) Tests for trends and association.

1. Correlation and testing for the trend.

2. Permutation chi-square test.

3. Fisher's exact test.

Math 325: Survey Sampling Methods

3 credits.

The theory and practice of sampling are introduced through a study of stratified random samples, simple random samples, cluster sampling, estimating sample size, ratio estimates, subsampling, two-state sampling and analysis of sampling error.

Sampling is a fundamental stage in virtually every statistical procedure and is primary to survey research. As such, a person who participates in the practice of sampling should have an understanding sufficient to give a unified basis to the sampling methods. Math 325 is an important course for students in education and the social, medical, biological and management sciences.

Syllabus

(a) Introduction.

(b) Review of statistical concepts.

(c) The sampling problem.

(d) Some sampling designs.

1. Simple random sampling.

2. Stratified random sampling.

3. Ratio, regression, and difference estimation.

4. Systematic sampling.

5. Cluster sampling.

6. Two-stage cluster sampling.

(e) Estimating the population size.

Math 326: Statistical Quality Control

3 credits.

The uses and concepts of probability and sampling procedures are introduced through a study of acceptance sampling by attributes and by variables, Shewhart concepts of process control, control chart process, capability studies, reliability, life testing and the design of sampling plans.

Quality control is a subject of interest and of practical use to any major who will become involved in managing, designing or controlling a manufacturing process. Industrial quality control is an important aspect of efficiency in manufacturing and many industries require personnel to be trained in this area. Math 326 is an important course for a variety of majors who are interested in an industrial career.

Syllabus

(a) Introduction to quality assurance and quality control.

(b) Review of probability and statistics.

(c) Introduction to control charts. (x, R, b, and o charts)

(d) Control chart patterns.

(e) Process capability studies.

(f) Fundamental concepts in acceptance sampling.

(g) Lot-by-lot acceptance sampling by attributes.

(h) Acceptance sampling by variables.

(i) Reliability and life testing.

(j) A quality control program.

5 The subject matter of this course has broad application to many disciplines.

Math 327: Categorical Data Analysis

3 credits.

This course introduces both parametric and nonparametric tools of categorical data analysis.

We often encounter response variables that are categorical in nature. For example, a researcher studies an association between passive smoking and serious health problems such as lung cancer. The response variable (presence/absence of serious health problems) is a categorical variable in this case, and familiar statistical methodologies for a continuous response such as ordinary regression are not applicable here.

In this course, methods for describing and analyzing contingency tables are introduced. Those include the Cochran-Mantel-Haenszel approach to detecting conditional association, loglinear model of association structure. A dichotomous response model, the logistic regression model, will be described and applied in several setting including cohort and case-control studies. Ordinal and polychotomous response models such as the cumulative and multinomial logit models will also be introduced. The statistical software SAS, e.g., procedures such as catmod, genmod, freq, and logistic, or/and the freeware package *R* will be used in this course.

Syllabus

(a) Introduction to categorical data analysis.

(b) Populations, samples, and probability distributions.

(c) Contingency tables and Chi-Square Statistics.

1. Marginal independence and conditional independence.

2. Poisson, binomial, and multinomial sampling.

3. Types of studies.

4. Pearson and likelihood-ratio chi-squared tests.

5. Fishers exact test.

6. Cochran-Mantel-Haenszel statistics.

(d) Logistic regression for dichotomous responses.

1. Simple logistic regression.

2. Multiple logistic regression.

3. Diagnostics and model selection.

(e) Logit models for multinomial responses.

(f) Loglinear models for count data.

Math 328: Time Series Analysis

3 credits.

This is an introductory course of time series and covers the basic concepts and methodologies related to time series data. The course discusses time series probabilistic properties, linear time series models, time series regression, forecasting, trend analysis, and model identification. Application of time series can be found in a variety of fields, such as agriculture, business, economics, engineering, and medical science. This course is crosslisted with Finance 328. Prerequisites for this course are Math 238 and Math 318.

Syllabus

1. Time series probabilistic properties

(a) Stationarity.

(b) Invertibility.

(c) Parameters (autocovariance, autocorrelation, and spectral density function).

2. Linear time series models

(a) White noise process.

(b) Autoregressive process of order p.

(c) Moving average process of order q.

(d) Autoregressive moving average process of orders p and q.

(e) Autoregressive integrated moving average process of orders p, d, and q.

3. Regression analysis

(a) Simple linear regression.

(b) Multiple linear regression.

(c) Residual analysis.

4. Forecasting

(a) Forecasting methods qualitative versus quantitative methods.

(b) Quantitative forecasting methods time series regression, classical decomposition, exponential smoothing.

(c) Measuring forecast errors.

5. Trend and seasonality

(a) Trend functions linear, quadratic, and polynomial.

(b) Seasonal component trigonometric functions.

6. Model identification

Math 336: Elementary Differential Equations

3 credits.

The theory of elementary differential equations is developed through a study of techniques for obtaining, analyzing and graphing solutions to differential equations, with emphasis on first and second order equations.

Math 336 is a course designed to give students the opportunity to understand how the ideas developed in calculus may be applied to widely diverse systems which undergo change.

Syllabus

(a) Techniques that follow directly from the calculus.

(b) A theory for second order linear equations.

(c) Power series and other numerical methods.

(d) The Picard iteration and its consequences.

Math 336 is required of all mathematics majors. The subject matter of this course has wide application and so it serves as an elective for other majors.

Math 337: Methods of Applied Calculus

3 credits.

Applications of calculus via the subject of vector analysis are introduced through a study of line and surface integrals, Green's theorem, the divergence theorem and Stokes' theorem and potential theory.

Math 337 is designed to give students exposure to applications from calculus to classical analysis and the physical sciences.

Syllabus

(a) Vector analysis

1. Multivariate functions.

2. Coordinate systems.

(b) Multivariate calculus.

1. Line and surface integrals.

2. Green's theorem.

3. The divergence theorem and Stokes' theorem.

4. Potential theory.

(c) Selected topics.

Math 337 serves as an elective in the mathematics major or minor. It is also an elective in the concentration in computational and applied mathematics. The topics in this course have broad applications and so this course serves as an elective for a variety of majors.

Math 340: Mathematical Modeling I - Optimization

3 credits.

Matrices and computers are used to model problems in the physical, biological, social, and management sciences. Linear and non-linear optimization methods will be stressed, along with computer visualization.

Mathematical modeling is becoming increasingly important in a wide variety of disciplines. This course provides an entry to the area of mathematical modeling for mathematics majors and non-majors alike. It is the first course of a year sequence in mathematical modeling that stresses computation and visualization and will help students perform research and find challenging employment after graduation. MATH 340 is part of a package that provides a wide range of students the opportunity to study mathematical modeling.

Syllabus

(a) Systems of linear equations.

1. Solving matrix equations.

2. Eigenvalues and eigenvectors.

3. Linear Equations with constraints, including Simplex method.

4. Applications of these methods, including to differential equations.

(b) Systems of nonlinear equations.

1. Multivariate calculus.

2. Taylor polynomials of one and two variables.

3. Newton-Raphson methods.

4. Optimization techniques.

5. Optimization techniques with constraints, including Lagrange methods and Kuhn-Tucker theory.

6. Applications of these methods to problems in areas such as economics and biology.

Math 340 is a course which serves as an elective in the mathematics major or minor. In addition, the topics in this course have broad applications and M340 serves as an elective for a variety of majors.

Math/Phys 341: Nonlinear Dynamics and Chaos

3 credits.

Introductory study of nonlinear dynamics and chaos primarily intended for upper-level undergraduates in science and mathematics. Topics include stability, bifurcations, phase portraits, strange attractors, fractals and selected applications of nonlinear dynamics in pure and applied science. Computers may be utilized for simulations and graphics.

While linear models may be completely analyzed through the tools of linear algebra and differential equations, nonlinear models typically have no exact solutions yet are commonly encountered in models of interacting systems. This course is designed to demonstrate to non-majors and majors in mathematics techniques of analyzing models with nonlinear dynamics.

Syllabus

(a) One-dimensional models.

1. Linear vs nonlinear models, vector fields on the phase-line, existence and uniqueness.

2. Fixed points, linearization near fixed points, stability analysis.

3. Bifurcations and parameter dependence of fixed points and stability.

4. Periodic flows and vector fields on the unit circle.

(b) Two-dimensional models.

1. Linear models, eigenvalues and eigenvectors, classifications of linear systems.

2. Vector fields in the phase-plane, phase-portraits, existence and uniqueness, types of possible solutions (PoincarBendixson Theorem).

3. Nullclines, fixed points, stability, linearization, classification of fixed-points, conservation laws, symmetries.

(c) Higher-dimensional models.

1. Generalizing aspects: existence and uniqueness, fixed points and linearization

2. Chaos: aperiodic, exponential sensitivity to initial conditions, Liapunov exponent, strange attractors

3. Fractals: self-similarity, iteration, fractal dimensions

Math 353: Graph Theory

3 credits.

Syllabus

(a) Graph theory.

1. Isomorphisms.

2. Euler trails and circuits.

3. Planar graphs.

4. Hamiltonian paths and circuits.

(b) Trees.

1. Rooted trees.

2. Sorting algorithms.

3. Spanning trees.

4. Weighted trees.

5. Optimization.

(c) Boolean algebras and switching functions.

(d) Selected topics.

1. Coding theory (optional).

2. Combinatorics (optional).

3. Computational complexity (optional).

This course covers material that is beginning to appear in the high school curriculum, so these courses are valuable electives for those who wish to earn teaching certifications.

Math 360: Complex Variables and its Applications

3 credits.

The subject of complex variables is developed through a study of the algebraic properties of the complex numbers, analytic functions, harmonic functions, mappings of elementary functions, contour integration, series, residues and poles and conformal mappings. Special emphasis is placed on computation and application to fluid and heat flow.

Math 360 is designed to provide students entry level theory and applications of classical complex analysis. The material covered in Math 360 has applications in the physical sciences to such phenomena as air glow over aircraft wings and heat flow through different laminae. Students majoring in the physical sciences who have studied calculus may take this course as an elective.

Syllabus

(a) Algebraic properties of the complex numbers.

(b) Analytic and harmonic functions.

(c) Heat and fluid flow problems.

(d) Mappings of elementary functions.

(e) Contour integration.

(f) Partial solutions to heat and fluid flow problems.

(g) Series, residues and poles.

(h) Applications to improper Reimann integrals and Laplace and Fourier transforms.

(i) Conformal mappings.

(j) Applications in heat and fluid flow problems.

Math 360 serves as an elective in the mathematics major or minor. It is also an elective in the concentration in computational and applied mathematics. The topics in this course have broad applications and so this course serves as an elective for a variety of majors.

Math 410-411: Advanced Calculus

3 credits each.

A complete development of the theory of calculus is undertaken through the study of limits, continuity, differentiation, sequences, series, integration and selected topics.

Math 410-411 is a two semester sequence that forms a capstone course for mathematics majors. All mathematics majors, except those seeking teacher certification, are required to complete either Math 430-431 or Math 410-411. The thrust of the course is to engage the student in proving theorems and to give them sufficient background in an area to begin to understand the beauty of a complete theory and how it is put together.

At least one capstone course (Math 410-411 or Math 430-431) is required of all mathematics majors.

Syllabi

1) Math 410

(a) Limits through continuity.

(b) Intermediate and extreme value theorems for continuous functions.

(c) Heine-Borel theorem.

(d) uniform continuity.

(e) derivatives.

Math 410 is required of all mathematics majors.

2) Math 411

(a) l'Hôpital's rule.

(b) Taylor's theorem.

(c) Definition of the integral.

(d) Existence of the integral.

(e) Properties of the integral.

(f) Countable sets.

(g) Sets of measure zero.

(h) Lebesgue's theorem.

(i) Sequences and series of functions.

(j) Uniform convergence

(k) Interchange of limits.

Math 411 is the completion of Math 410. This course serves as an elective in the mathematics major and together the sequence forms a capstone course.

Math 415: History of Mathematics

3 credits.

Topics in the history of mathematics from ancient times to the present are incorporated in the curriculum to develop an appreciation of the place of mathematics in the general culture and to give an overview of the historical development of the discipline of mathematics.

Math 415 is designed to help students of mathematics develop both a broader and deeper view of the discipline. The subject matter of this course is especially appropriate for students who wish to teach mathematics.

Syllabus

(a) Major themes.

1. Foundations of mathematics.

2. Infinitesimal analysis.

3. Development of the real number system.

4. Limit concept.

5. Computing devices and machines.

(b) Topics integrated into these themes.

1. Axiomatics, consistency, independence and equivalence.

2. Ancient numeration systems and bases other than ten.

3. The discovery of incommensurables.

4. Euclid – books I and V.

5. Archimedes' quadrature and method.

6. Cavalieri's indivisibles, Roberval's quadrature of the cycloid, infinitesimal methods.

7. Cardano and the "Cossic" art (the cubic).

8. The impossibility of the quintic.

9. Galois theory.

10. The three classical problems.

11. Tally sticks and the abacus.

12. Dedekind cuts.

13. Peano postulates.

14. Cantor's transfinite arithmetic.
15. The parallel postulate.
16. Non-Euclidean geometries.
17. Gauss construction of the regular n-gons.
18. Newton and Leibnitz and the lack of rigor in analysis.
19. Non-standard analysis.
20. Boolean algebra.
21. Quaternians and electromagnetic radiation.
22. The role of computers in WW II.
23. Artificial intelligence.
24. Independence of the axiom of choice and the continuum hypothesis from the axioms for set theory.
25. The loss of certainty in mathematics.

Math 415 serves as an elective for all mathematics majors.

Math 421: Applied Multivariate Statistical Analysis

3 credits.

Multivariate statistical analysis is developed through a study of several topics, including canonical correlation, clustering, discriminant analysis, factor analysis, multivariate analysis of variance, multiple regression, multidimensional scaling and principal components analysis.

Math 421 provides students with methods of analysis that are an integral part of the standard arsenal of analytic tools available to applied statisticians. The course is designed for students who have had Math 300 or Math 238 and a statistics course (Math 321 or Math 322) as a prerequisite. The subject matter of this course is of particular importance to social scientists, biologists and management scientists who use quantitative methods of analysis.

Syllabus

(a) Univariate techniques using matrix notation.

(b) Multivariate Normal Distribution

(c) Principal Components analysis.

(d) Factor analysis

(e) Cluster analysis.

(f) Discriminant analysis.

(g) Multivariate analysis of variance.

(h) Multiple regression.

(i) Canonical correlation analysis.

(j) Loglinear models.

Math 423: Stochastic Processes

3 credits.

Stochastic Processes are developed through a study of sequences and classes of random variables such as Markov chains, branching processes, the Poisson process, queuing systems and renewal processes. The course prerequisites are Math 238 (or Math 300 or equivalent) and Math 318.

Math 423 is designed to provide students in the physical, biological, social and management sciences the opportunity to study more sophisticated statistical processes. The subject matter of this course has broad application to many disciplines.

Syllabus

(a) Preliminaries in probability.

(b) Markov chains.

1. Transition probabilities and the Chapman-Kolmogorov equation.

2. Classification of states.

3. Limiting probabilities.

(c) Branching processes.

1. Extinction probabilities.

2. Total progeny.

(d) The Poisson process.

1. Construction of a Poisson process.

2. Waiting time and inter-event time distributions.

3. Compound Poisson processes.

(e) Applications.

Math 424: Statistical Decision Theory

3 credits.

MATH 424 is designed to provide mathematics or statistics majors with an opportunity of studying statistical inference from the viewpoints of more general and sophisticated decision theories.

Syllabus

(a) Some basic geometry of the n-dimensional Euclidean space.

(b) The state space, action space, and loss function.

(c) Statistical decision functions and risk functions.

(d) Dominance, admissibility, and completeness.

(e) The minimax principle and its geometry.

(f) Bayes procedure and its geometry.

(g) Applications to parameter estimation and hypothesis testing.

Math 426-427: Probability and Mathematical Statistics I and II

3 credits each.

The theories of probability and statistics are developed through a systematic study of probability, random variables and vectors, discrete and continuous distributions, mathematical expectation, moment generating functions, properties of estimators, asymptotic theory, theory and applications of estimation and hypothesis testing, and linear statistical models.

Math 426-427 is a two-semester sequence that forms a capstone course in the statistics offerings. Math 426 is required for statistics majors, both mathematical-statistics and applied-statistics tracks. Math 427 is required only for statistics majors in mathematical-statistics track.

The subject matter of these courses is particularly suited to students who wish to go on to graduate study in statistics or to employment at an entry level statistics position in business, industry, and government.

Syllabi

Math 426

(a) Probability.

(b) Random variables and random vectors.

(c) Expectation.

1. Moment generating functions.

2. Conditional expectation.

(d) Common probability distributions.

1. Binomial and Poisson.

2. Normal, t, F, uniform, gamma family, beta.

3. Relations among distributions.

(e) Bivariate normal distributions.

(f) Asymptotic theory.

1. Almost sure convergence and strong law of large numbers.

2. Convergence in probability and weak law of large numbers.

3. Convergence in distribution and central limit theorem.

Math 427

(a) Estimation.

1. Maximum likelihood estimators.

2. Unbiased estimators.

3. Consistent estimators.

4. Minimum variance unbiased estimators.

(b) Confidence intervals and statistical tests.

1. Pivotal quantities.

2. Testing statistical hypotheses.

3. Power functions.

(c) Sufficient statistics.

1. Factorization theorem.

2. Exponential family of distributions.

3. Minimal and complete sufficiency.

4. Ancillary statistics.

(d) Optimal tests.

1. Most powerful tests.

2. Likelihood ratio tests.

(e) Linear statistical models.

1. Linear regression.

2. Analysis of variance.

Math 430-431: Abstract Algebra

3 credits each.

The basic theory of abstract algebra is developed through a systematic study of algebraic structures including groups, rings and fields.

Math 430-431 is a two semester sequence that forms a capstone course for mathematics majors. All mathematics majors, except those seeking teacher certification, are required to complete either Math 430-431 or Math 410-411. The thrust of the course is to engage the student in proving theorems and to give them sufficient background in an area to begin to understand the beauty of a complete theory and how it is put together.

Syllabi

1) Math 430

(a) Sets and relations.

(b) Equivalence relations.

(c) Congruences.

(d) Rings

1. Definition and examples.

2. Commutativity.

3. Identity.

4. Units.

5. Homomorphisms and isomorphisms.

6. Quotient rings.

7. Order.

8. The integers and the division algorithm.

9. Elementary number theory.

(e) Integral domains.

(f) Fields.

(g) Fields of quotients.

(h) Factorization and polynomial rings.

Math 430 is required of all mathematics majors.

2) Math 431

(a) Ideals and Field extensions.

(b) Groups.

(c) Finite groups.

(d) Finite abelian groups.

Math 431 is the completion of Math 430. This course serves as an elective in the mathematics major and together the sequence forms a capstone course.

Math 435: Introduction to Topology

3 credits.

The elementary concepts of topology are developed through a study of metric spaces, limits, continuous maps and homeomorphisms, connectedness, compact topological spaces and applications.

Math 435 is designed to continue the process of abstraction and the development of proof. Basic definitions and concepts are introduced and used to establish a basis for the understanding of factual information that is often taken for granted, such as the statement "the continuous image of a connected segment is connected." The subject matter of this course is particularly useful to students who wish to pursue graduate study in mathematics or undertake a research project in pure mathematics.

Syllabus

1. Topological Spaces and subspaces
2. Continuity and homeomorphisms
3. Product spaces
4. Connectedness
5. Compactness
6. Hausdorff spaces
7. Metric spaces

Math 435 is an elective in the mathematics major. This course is an elective in the pure concentration and serves as an elective for any student wishing to minor in mathematics.

Math 440: Fourier Analysis and Partial Differential Equations

3 credits.

Fourier analysis and partial differential equations (pdes) are introduced through a study of elementary applied partial differential equations such as the wave equation, the heat equation, and Laplace's equation. First order and second order linear pdes are treated as well as the development of Fourier series. Math 440 includes the development of both the theory of the subject and problem solving skills. This course will also enhance problem-solving skills and illuminate the various issues in mathematical theory and applications of initial-value problems, boundary-value problems, and initial-boundary value problems for partial differential equations.

Syllabus

(a) Ordinary differential equation review.

(b) Classical partial differential operators and physical derivations.

1. Wave operator/Wave equation.
2. Diffusion operator/Heat equation.
3. Potential operator/Laplaces equation.

(c) First order partial differential equations and method of characteristics. dAlemberts formula.

(d) Classification of 2nd order partial differential equations.

(e) Classic initial-value, initial-boundary value, and boundary value problems.

(f) Classical Solution Methods: Separation of variables, Fourier series, eigenfunction expansion.

(g) Mathematical tools: Well-posedness, Convergence Theorems for Fourier series.

(h) Selected additional topics as time allows.

Taken with Math 441, the sequence Math 440-441 is one of the options available for students interested in

applied mathematics to fulfill math major requirements. Math 440 can also be used as an elective in the mathematics major, and given the classical nature of the topic, is also taken as an elective or requirement in several other majors, including physics and quantitative finance.

Math 441: Analysis and Dynamics of Differential Equations

3 credits.

Many applications in biology, chemistry, finance, and physics result in non-linear differential equations where formulas of solutions are not available.

Thus, Math 441 is designed to teach students how to analyze and derive the qualitative properties of differential equations, especially non-linear differential. The subjects include the existence and uniqueness of solutions, phase portraits analysis, dynamics of systems, stability, and if time permits, bifurcations and chaos. This course will equip students with more tools when they apply the knowledge of qualitative analysis to problem-solving.

Math 441 is on the borderline of applied and pure mathematics, and can be used as an elective for both. Also, 440-441 can be used as one option to satisfy the math major requirement. The knowledge gained in this course will strengthen students overall analysis skills, which are increasingly important and desirable in graduate studies and careers.

Syllabus

a. Examples of non-linear differential equations from sciences

b. Existence and uniqueness

c. Continuous dependence

d. Linear differential equations

e. Matrix analysis

f. Autonomous differential equations

g. Phase portraits analysis

h. Dynamics of systems

i. Stability

j. Applications

Math/CS 448: Numerical Mathematics

3 credits. (Math/CS 449: Numerical Analysis for Differential Equations. 3 credits.)

The subject of numerical mathematics is developed through a study of numerical solutions and error analysis of typical problems such as; finding zeros of nonlinear functions, solving systems of linear and nonlinear equations, interpolation, approximation, integration, solving ordinary and partial differential equations, optimization and Monte Carlo methods.

Math 448 and Math 449 are designed to give students an opportunity to study in-depth applications of mathematics and to learn numerical calculus. They introduce the students to a study of using numerical methods to approximate solutions to equations and to implement them on the computer using a high level computing language and visualization and graphics packages. This course is useful to students in any

discipline who are using computer models to simulate problems of interest.

Syllabi

1) Math 448

(a) Numbers systems, convergence, stability, error analysis.

(b) Zeroes of functions of one variable.

(c) Interpolating polynomials - Vandermonde, Lagrange, Newton, Taylor.

(d) Numerical differentiation.

(e) Numerical integration.

(f) Systems of linear equations.

(g) Systems of non-linear equations.

Taken with Math 449, the sequence is one of the options available for students interested in applied mathematics to fulfill math major requirements.

2) Math 449

(a) Numerical methods for approximating solutions to ode's.

(b) Numerical methods for approximating solutions to pde's.

Taken with Math 448, the sequence is one of the options available for students interested in applied mathematics to fulfill math major requirements.

Math 475: Fundamental Concepts of Geometry

3 credits.

The foundations of geometry are developed through a study of the origins, axioms, proofs and selected topics from incidence geometry.

Math 475 is a course designed to provide students a sophisticated exposure to the axiomatic development of geometry. The subject matter of this course is particularly appropriate for students who wish to become secondary teachers.

Syllabus

(a) Axioms for selected finite geometries.

(b) The Pappus, Desargues and Fano configurations.

(c) Axioms for Euclidean geometry.

(d) Transformations.

(e) Isometries.

(f) Similarities.

(g) Convexity.

(h) Euclidean geometry of the polygon and circle.

(i) The theorem of Menelaus and its converse.

(j) The theorem of Ceva and its converse.

(k) The axioms of Hilbert.

(l) The axioms of Birkhoff.

(m) logical considerations.

(n) Geometric constructions.

Math 475 is an elective in the mathematics major.

Math 522: Statistics for Researchers

3 credits.

Math 522 consists of an introduction to statistics and statistical methods including descriptive techniques, normal distribution, tests of hypotheses, confidence intervals, regression, analysis of variance, and nonparametric procedures. Topics include the t-tests, One- and Two-Way ANOVA, Randomized Block models, Mann-Whitney Test, Kruskal-Wallis test, Friedman test, Chi-Square Test of Independence, Simpsons paradox and the Mantel-Haenszel method, and Logistic Regression.