



## **A Letter to Prospective Mathematics Majors/Minors**

*Dear Prospective Mathematics Student:*

*Thank you for your interest in the undergraduate mathematics programs at Kent State University. The Department of Mathematical Sciences offers a wide variety of options and mathematical areas for students who wish to pursue a major or minor in mathematics. All of our programs are designed to broaden and deepen your mathematical perspective and understanding.*

*We offer major and minor programs in both pure and applied mathematics. The pure mathematics major is very flexible in order to meet your individual needs and interests. The applied mathematics major allows for a concentration in classical applied mathematics, computational mathematics, probability and statistics, or financial mathematics. Our programs can prepare you for employment in industry, government, or education, or prepare you for graduate study.*

*The Department of Mathematical Sciences has approximately 25 faculty in diverse areas, including algebra, analysis, topology, applied mathematics, probability, and statistics. The faculty is committed to quality teaching enhanced by original mathematical research. This results in an academic atmosphere that encourages your intellectual growth and development.*

*With a strong high school mathematics background, you will probably begin with the first course in our calculus sequence, although some students starting a mathematics program may require a pre-calculus course. All mathematics majors and minors take calculus, linear algebra, and introductory computer science before proceeding to more advanced courses.*

*Current information about Kent State University and the Department of Mathematical Sciences can be found at <http://www.kent.edu> and <http://www.math.kent.edu>, respectively.*

*The Department of Mathematical Sciences  
at Kent State University*

## **THE UNDERGRADUATE PROGRAM**

There are many benefits to majoring or minoring in mathematics. These include a wide variety of career opportunities and a relatively high earning potential. Many employment opportunities for mathematicians exist in government, industry, and education. To learn more about possible careers that use mathematics, visit the Early Career Profiles page: <http://www.ams.org/early-careers>.

Moreover, the options that are available in choosing between mathematics and applied mathematics allow for a high degree of flexibility in designing one's program of study. Students can choose from a large variety of elective mathematics courses. In addition, students can pursue a dual major, such as mathematics and physics, or incorporate into a math major a related minor, such as computer science. Students in areas such as business, economics, finance, and social sciences can greatly improve their marketability by obtaining a minor in mathematics or applied mathematics. A minor in one of the mathematics areas is a particularly good option for students majoring in the sciences.

The flexibility of our mathematics minor programs is illustrated by the requirements for these minors. Excluding the basic, prerequisite courses, minors in mathematics and applied mathematics consist of 25 credit hours, including calculus. There are numerous options for the courses beyond the calculus sequence.

While almost any mathematics degree will provide great benefits for a student, there are many advantages to studying mathematics at Kent State University. These include the fact that our professors regularly teach courses at all levels (entry level, upper division, and graduate). Most class sizes are small and there is free tutoring available to all students throughout the afternoon and evening. Students have free access to many types of computer resources. In addition, scholarships, student jobs, and other forms of financial aid are available to students majoring or minoring in the mathematical sciences.

### **PROGRAMS IN MATHEMATICS:**

#### **MATHEMATICS - APPLIED MATHEMATICS - STATISTICS**

At Kent State University, the primary concern is the student. The Department of Mathematical Sciences reflects this concern through its efforts to provide the academic atmosphere and close student-faculty associations that encourage intellectual growth and development. Programs are designed to broaden students' perspectives and to help them realize their potential. Kent State offers courses in mathematics (pure and applied), computer science, statistics, actuarial sciences, and mathematics for teachers. A student may concentrate in one area or combine coursework from several

areas. Programs allow a student to prepare for graduate study, for high school teaching, or for employment in industry.

An undergraduate specializing in mathematics will begin with calculus and introduction to computing, although some students will require college algebra and trigonometry. Well-prepared students are encouraged to establish credit in elementary courses by passing advanced standing examinations. All majors take courses in calculus, computer science, and linear algebra.

### **PREPARATION FOR A MATHEMATICS CAREER**

Students interested in careers as mathematicians should pursue either the Mathematics Program or the Applied Mathematics Program. The Mathematics Program is strongly recommended for students considering graduate study in mathematics. The Applied Mathematics Program is flexible and designed to suit the needs of students interested in a career in industry or government or in postgraduate study in applied mathematics or other scientific areas.

It is strongly recommended that all majors plan to take the Graduate Record Examination (GRE) early in their senior year. This exam is a requirement for almost all graduate programs. Taking the exam while your course work is fresh in your memory will help keep your options for graduate work open.

### **PREPARATION FOR A TEACHING CAREER**

Students interested in high school teaching may pursue either the Bachelor of Science or Arts in the College of Arts and Sciences, majoring in one of the mathematical sciences with a minor in secondary education, or the Bachelor of Science in Education, with a major or minor in mathematics. Either of these programs leads to teacher certification in the state of Ohio.

### **JOB OPPORTUNITIES**

A degree in the mathematical sciences can lead to various careers in education, industry, and government. Because of the skill in reasoning developed by mathematical training, a degree in mathematics is a positive asset when applying for many positions. Further information on careers in mathematics may be obtained from the following websites:

<http://www.ams.org/careers>

<http://www.maa.org/students/career.html>

<http://www.siam.org/careers>

The Kent State University Career Services Center can provide students with many valuable resources including help with finding on and off campus student employment.

## DEGREE REQUIREMENTS IN MATHEMATICS

A major or minor in mathematics is an important part of many degrees. For example, students interested in Secondary Math Education may pursue a minor or a major in mathematics. Computer Science majors wishing to apply for admission and financial support to some of the most competitive graduate programs in computer science are strongly encouraged to obtain at least a minor, and preferably a major, in mathematics (pure or applied). Students majoring in science, business, or pre-law can greatly benefit from a minor or major in Mathematics. The requirements for math majors and minors are listed below. (See the Undergraduate Catalog for more details.)

### MAJORS:

#### ***Mandatory Outcomes Assessment:***

A general graduation requirement of the College of Arts and Sciences is participation in Outcomes Assessment. For majors in the Department of Mathematical Sciences, this consists of participation in the Senior Colloquium and Senior Exit Survey in the spring of the senior year, and possibly submission of a Graduation Portfolio, depending on the year in which the major begins. See the web page <http://www.math.kent.edu/~white/assessment> for further details.

#### ***General Mathematics Requirement:***

MATH 12002	Analytic Geometry and Calculus I	5
MATH 12003	Analytic Geometry and Calculus II	5
MATH 21001	Linear Algebra with Applications	3
MATH 22005	Analytic Geometry and Calculus III	3
CS 10051	Introduction to Computer Science	4
Total=		20

#### **B.A. IN MATHEMATICS**

General Mathematics Requirement	20	
One of the sequences:		
MATH 41001, 41002	Intro. to Modern Algebra I, II	6
MATH 42001, 42002	Intro. to Analysis I, II	6
Approved 40000-level Courses:	9	
Total=	35	

#### **B.S. IN MATHEMATICS**

General Mathematics Requirement	20	
MATH 41001, 41002	Intro. to Modern Algebra I,II	6
MATH 41021	Theory of Matrices	3
MATH 42001, 42002	Intro. to Analysis I,II	6
PHYS 23101	General University Physics I	5
Approved Courses:	27	
Total=	67	

#### **B.S. IN MATHEMATICS, Actuarial Mathematics Option**

An Actuarial Mathematics Option is available for Mathematics majors with an interest in actuarial careers. In this option, most electives are fulfilled with courses in probability, statistics, theory of

interest, and actuarial mathematics. Contact Dr. M. K. Khan or Dr. R. Shoop for details and advising.

## B.S. IN APPLIED MATHEMATICS

General Mathematics Requirement	20
MATH 32044 Intro. to Ordinary Differential Eqs.	3
MATH 40011 Intro. to Probability Theory and Appl.	3
MATH 40012 Introduction to Statistical Concepts	3
MATH 41021 Theory of Matrices	3
MATH 42031 Mathematical Models	3
MATH 42091 Seminar: Modeling Projects	3
MATH 42201, 42202 Numerical Computing I, II	6
CS 23021 CS I: Programming & Prob. Solving	4
PHYS 23101, 23102 General University Physics I, II	10

One of the following concentrations:

### ***Applied Mathematics:***

MATH 42041 Advanced Calculus	3
MATH 42045 Intro. to Partial Differential Equations	3
MATH 42048 Introduction to Complex Variables	3
Approved Electives:	6

### ***Computational Mathematics:***

MATH 23022 Discrete Structures for Comp. Sci.	3
CS 33001 CS II: Data Structures & Abstraction	3
Approved Electives:	9

### ***Probability and Statistics:***

MATH 40051 Topics Prob. Th. & Stochastic Proc.	3
Choose one:	
MATH 40041 Stats. Methods for Experiments	3
MATH 40042 Sampling Theory	3
Approved Electives:	9

### ***Financial Mathematics:***

ACCT 23020 Intro. to Financial Accounting	3
FIN 36053 Business Finance	3
MATH 40051 Topics Prob. Th. & Stochastic Proc.	3
MATH 42045 Intro. to Partial Differential Equations	3
Approved Electives:	3

Total= 73

## **MINORS:**

### ***Prerequisite:***

CS	10051 Intro. to Computer Science	4
	OR	
CS	10061 Intro. to Computer Programming	3

### ***Core Requirement:***

MATH	12002 Analytic Geometry and Calculus I	5
MATH	12003 Analytic Geometry and Calculus II	5
MATH	21001 Linear Algebra with Applications	3
MATH	22005 Analytic Geometry and Calculus III	3
	Total= 16	

## **MATHEMATICS MINOR**

Core Requirement	16
Choose two courses from ONE of the categories:	
<i>Algebra</i>	6
<i>Analysis</i>	6
<i>Geometry/Topology</i>	6
Approved Courses:	3
Total= 25	

## **APPLIED MATHEMATICS MINOR**

Core Requirement	16
MATH 32044 Intro. to Ordinary Differential Eqs.	3
Approved Courses:	6
Total= 25	

## **B.A. or B.S. Degree with Minor in Secondary Education**

Candidates for either the B.A. or B.S. degree in the College of Arts and Sciences may complete requirements for a minor in secondary education leading to teacher certification in the state of Ohio. Application should be made in the Office of the Assistant Dean for Student Personnel, 306 White Hall. All mathematics requirements for the B.A. or B.S. and the Secondary Education Mathematics Requirements listed under the Bachelor of Science in Education degree must be satisfied. A course may be used to satisfy a requirement in both programs but then extra electives are required.

## **SECONDARY EDUCATION REQUIREMENTS:**

General Mathematics Requirement	20
MATH 31011 Discrete Mathematics	3
MATH 34002 Fund. Concepts of Geometry	3
One of the following:	
MATH 34001 Fundamental Concepts of Algebra	3
MATH 41001 Introduction to Modern Algebra I	3
One of the following:	
MATH 41001 Introduction to Modern Algebra I	3
MATH 42001 Introduction to Analysis I	3

MATH 46001 Elementary Topology	3
MATH 47011 Theory of Numbers	3

One of the following:

MATH 45011 Differential Geometry	3
MATH 45021 Euclidean Geometry	3
MATH 45022 Linear Geometry	3

One of the following:

MATH 40011 Intro. to Probability Theory & Appl.	3
MATH 42011 Mathematical Optimization	3
MATH 42021 Graph Theory and Combinatorics	3
MATH 42031 Mathematical Models	3
MATH 32044 Intro. to Ordinary Differential Eqs.	3
MATH 42048 Introduction to Complex Variables	3
MATH 42201 Intro. to Numerical Computing I	3

Approved Courses: 3-6  
 Total= 41-44

### **Bachelor of Science in Integrated Mathematics (B.S. in IMTH)**

The B.S. in IMTH is granted by the College of Education. The student devotes approximately 37 hours of his/her time to professional preparation and 40 hours to mathematics courses. To obtain this degree with either a major or a minor in mathematics, the general requirements of the College of Education ADED program must be satisfied along with the IMTH mathematics requirements.

### **AWARDS AND SCHOLARSHIPS**

- *Kenneth B. Cummins Mathematics Award* (amount of award varies). Awarded to the most promising junior mathematics major preparing to teach mathematics in the secondary schools. Application forms available from the departmental office.
- *Harshbarger Scholarship* (amount of award varies). Available to any mathematics major who has completed the general Mathematics requirement (see page 2) and either MATH 22005 (third semester calculus) or an upper-division mathematics course. Application forms available from the departmental office.
- *Honorary Mathematics Scholarship* (\$3500). This scholarship is offered jointly with the Honors College and is awarded to a talented freshman who has demonstrated truly unusual or exceptional proficiency in mathematical skills (for example: achieving a high ranking on the AHSME).
- *High School Math Competition*. Incoming freshmen can accumulate between \$500 and \$4,000 by participating in these competitions.

- *Pi Mu Epsilon Award* (\$100 and a book). Awarded to an outstanding upper-class student in mathematics.

Each fall the Department of Mathematical Sciences holds a High School Math Scholarship competition. Annual awards generally range from \$500 to \$1,000 and scholarships can be accumulated over the years. All high school students are eligible to participate. For more information contact Professor Laura Smithies.

There are also university-wide resources. More than 5,000 students are employed annually at Kent State University. A free listing of employment opportunities is available through K.S.U. Career Services Center. The career services center also helps students find off campus employment.

The Kent State University student financial aid site [www.sfa.kent.edu](http://www.sfa.kent.edu) describes many options for financial aid. Some notable options for Math majors are:

- *KSU Founders Scholarships*. (Based on a scholarship competition.)
- *Honors College Scholarships*. (Requires student to join the Honors College.)
- *Grand Lodge of Free and Accepted Masons of Ohio Scholarship*. (Based on G.P.A. and financial need.)

Special Financial Aid Awards (for members of certain groups such as women, minorities, certain high schools, children of employees, etc.): Akron Urban League, Filmco Scholarship, Idabelle Hoose Memorial Scholarship, Carol Shoults Memorial Scholarship, Spinneweber-Sheats Memorial Scholarship, Seven Seventeen Credit Union Scholarship.

There are also many sources of financial aid based outside Kent State University. These include [www.collegenet.com/mach25](http://www.collegenet.com/mach25), which is a site containing more than 600,000 private sector and institutional awards. The site [www.fastweb.com](http://www.fastweb.com) has a database of more than 270,000 private sector scholarships, fellowships, grants and loans, and a similar web site is located at [www.srnexpress.com](http://www.srnexpress.com). The College Board's database for financial aid is located at [www.collegeboard.com/student/pay](http://www.collegeboard.com/student/pay). We also recommend the site [www.collegeanswer.com](http://www.collegeanswer.com), the College Aid Sources for Higher Education, which is a free financial aid service offered by Sallie Mae.

Additional information on financial aid is available through your local library, the K.S.U. library, your high school guidance counselor, and the KSU Financial Aid Office (330) 672-2972. You can also contact the Kent State University Department of Mathematical Sciences directly at (330)672-2430 or at the address on the back of this brochure.

## Course Database

### **12002 Analytic Geometry and Calculus I (5)**

Concepts of limit, continuity, the derivative, and the indefinite and definite integral for functions of one real variable. Maximization, related rates. Fundamental Theorem of Calculus. Prerequisite: A grade of C (2.0) or better in MATH 12001 or in MATH 11022 and one of 11010 or 11011, or appropriate placement test score; no credit for 12011 or 12012. This course may be used to satisfy the LERs.

### **12003 Analytic Geometry and Calculus II (5)**

Continued study of techniques and applications of integration; trigonometric, logarithmic, and exponential functions; polar coordinates; vectors; parametric equations; sequences and series. Prerequisite: MATH 12002 or MATH 12012.

### **2095 Special Topics in Mathematics (1-5)**

Various special courses will be announced in the Schedule of Classes under this course number with different section numbers. Repeated registration permitted. Prerequisite: Permission.

### **21001 Linear Algebra with Applications (3)**

Systems of linear equations and the associated matrix operations, linear transformations, vector spaces, bases, eigenvectors. Prerequisite: MATH 11012 or 12002.

### **22005 Analytic Geometry and Calculus III (3)**

Study of functions of several variables, including partial derivatives and multiple integrals. Prerequisite: MATH 12003.

### **23022 Discrete Structures for Computer Science (3)**

(Cross-listed with CS 23022) Discrete structures for computer scientists with a focus on: mathematical reasoning, combinatorial analysis, discrete structures, algorithmic thinking, applications, and modeling. Specific topics include logic, sets, functions, relations, algorithms, proof techniques, counting, graphs, trees, Boolean algebra, grammars, and languages. Prerequisites: CS 10051; a grade of C (2.0) or better in MATH 12001, or in MATH 11022 and one of 11010 or 11011, or appropriate placement test score into MATH 12002; no credit for MATH 31011.

### **30011 Basic Probability and Statistics (3)**

Analysis and representation of data. Controlled experiments and observations. Measurement errors. Correlation and regression. Sampling. Probability models and tests of models. Inference. Prerequisite: A grade of C (2.0) or better in MATH 11010, 11011, or 12001.

### **31011 Discrete Mathematics (3)**

Discrete mathematical techniques and structures including finite set theory, graph theory, propositional calculus, combinatorics, and discrete probability. Formal methodology and proof techniques. Prerequisites: MATH 12002 and 21001 (concurrent registration in MATH 21001 allowed) and no credit for MATH 23022.

### **31045 Formal Logic (3)**

(Cross-listed with CS 31045 and PHIL 31045) Study of first order predicate calculus with identity and function symbols. Prerequisite: None.

### **32044 Introduction to Ordinary Differential Equations (3)**

An introduction to ordinary differential equations and applications. Topics include solution methods, series solutions, and singular points. Laplace transforms and linear systems. Applications include population dynamics, forced oscillations and resonance. Prerequisites: MATH 21001 and 22005.

### **34001 Fundamental Concepts of Algebra (3)**

Professionalized course in algebra for prospective secondary teachers. Postulational development of number systems of algebra; other systems, related topics, applications. Prerequisite: MATH 12002.

### **34002 Fundamental Concepts of Geometry (3)**

Professionalized course in geometry for secondary school teachers. Origin and development of the geometry of Euclid with modern refinements, topics, approaches. Other geometries, applications. Prerequisite: MATH 12002.

### **40011 Introduction to Probability Theory and Applications (3)**

Permutations and combinations, discrete and continuous distributions, random variables, conditional probabilities, Baye's formula, mathematical expectation, law of large numbers, normal approximations, basic limit theorems. Prerequisite: MATH 12003.

**40012 Introduction to Statistical Concepts (3)**

Sample spaces, continuous distributions, sampling distributions, point and interval estimation, hypothesis testing, types of error, level and power of tests, sequential and non-parametric methods. Prerequisite: MATH 4/50011.

**40022 Linear Models and Statistical Analysis (3)**

Regression model, multivariate normal distribution, point and interval estimates, Gauss-Markov Theorem, correlation and regression, tests of hypotheses, applications. Prerequisites: MATH 21001 and 40012.

**40031 Basic Nonparametric Statistics (3)**

Rank tests for different kinds of hypothesis, large sample theory, efficiency comparisons, tests of Kolmogorov-Smirnov type. Prerequisite: MATH 40012.

**40041 Statistical Methods for Experiments (3)**

Comparison of two groups, t- and F- statistics, ANOVA, one-way and multiway layouts, randomization, blocking. Linear regression, correlation, and analysis of covariance (ANCOVA). Repeated measures analysis of variance. Prerequisite: MATH 30011 or permission.

**40042 Sampling Theory (3)**

This introductory course provides the methodology for the design and analysis of sampling and surveying studies. Simple random, stratified, cluster, PPS and two-stage sampling techniques. Linear, ratio and regression estimators. Prerequisite: MATH 30011 or equivalent.

**40051 Topics in Probability Theory and Stochastic Processes (3)**

Topics from random walks, renewal theory, Markov processes, branching processes and birth-death processes. Brownian motion and other simple processes with applications. Prerequisite MATH 40011.

**40093 Variable Title Workshop in Mathematics (1-6)**

Studies special topics in mathematics. Not acceptable for credit toward a major or minor in math without approval of student's adviser. S/U grading. Prerequisite: Permission.

**41001 Introduction to Modern Algebra I (3)**

Basic properties of groups, subgroups, factor groups. Basic properties of rings, integral domains, and homomorphisms. Prerequisites: MATH 21001 and 22005. This course may be used to satisfy the writing-intensive course graduation requirement with approval of major department.

**41002 Introduction to Modern Algebra II (3)**

A continuation of MATH 41001, emphasizing properties of rings, their ideals, polynomial ring extensions, fields, finite degree extensions, roots of polynomials, constructability. Prerequisite: MATH 41001 or permission. This course may be used to satisfy the writing-intensive course graduation requirement with approval of major department.

**41012 Finite Mathematics (3)**

(Cross-listed with CS 41012) A continuation of Discrete Math, emphasizing combinatorial techniques, graph applications in algorithms, finite algebra, number theory and probability. Covers useful math for CS majors. Prerequisite: CS 31011 or MATH 31011.

**41021 Theory of Matrices (3)**

A rigorous study of the topics introduced in matrix algebra. Topics included are: vector space preliminaries, canonical forms of matrices, diagonalizability criteria. Prerequisites: MATH 21001 and 22005 or permission.

**41045 Metalogic (3)**

(Cross-listed with CS 41045 and PHIL 41045) May be counted toward B.A. or B.S. mathematics major. See PHIL 41045 for description. Prerequisite: PHIL 31045 or permission.

**42001 Introduction to Analysis I (3)**

Topics include basic structure of the real numbers, Cauchy sequences, convergence; completeness of the real numbers, continuity, differentiation and Riemann integration. Prerequisite: MATH 21001 and 22005 or permission. This course may be used to satisfy the writing-intensive course graduation requirement with approval of major department.

**42002 Introduction to Analysis II (3)**

Topics include further development of integration theory, infinite series, uniform convergence, several variable calculus, and metric spaces. Prerequisite: MATH 42001. This course may be used to satisfy the writing-intensive course graduation requirement with approval of major department.

**42011 Mathematical Optimization (3)**

Analytic and numerical techniques for location of extreme points of functions and calculus of variations. Both constrained and unconstrained problems are considered. Prerequisites: MATH 21001 and 22005 or permission.

**42021 Graph Theory and Combinatorics (3)**

Fundamentals and applications of combinatorial mathematics. Topics include traversability, colorability, networks, inclusion and exclusion, matching and designs. Prerequisites: MATH 21001 and 22005 or permission.

**42024 Numbers and Games (3)**

The study of partisan and impartial combinatorial games; games as numbers; Grundy-Sprague theory. Prerequisites: MATH 21001 or permission.

**42031 Mathematical Models and Dynamical Systems (3)**

Formulation and analysis of mathematical models for a variety of phenomena. Mathematical methods from optimization, dynamical systems and probability are developed and applied. Modern software tools are utilized. Prerequisite: MATH 32044.

**42041 Advanced Calculus (3)**

The calculus and applications of scalar and vector functions of several variables. Vector differential and integral calculus. Applications to field theories, electricity and magnetism, and fluid flow. Prerequisite: MATH 21001 and 22005.

**42045 Introduction to Partial Differential Equations (3)**

An introduction to Fourier series, Fourier transforms, and partial differential equations. Wave, heat, and potential equations of mathematical physics. Additional topics include Green's functions and the Method of Characteristics for wave equations. Prerequisite: MATH 32044.

**42048 Introduction to Complex Variables (3)**

Algebra of complex numbers, analytic functions, mappings, Cauchy integral theory, residue theory, and applications. Prerequisite: MATH 22005.

**42091 Seminar: Modeling Projects (3)**

Individual and small-group projects concerned with the formulation and analysis of mathematical models in a variety of areas. Written and oral reports are required. Prerequisite: MATH 42031. This course may be used to satisfy the writing intensive course graduation requirement with approval of major department.

**42201 Numerical Computing I (3)**

(Cross-listed with CS 42201) An introduction to numerical methods and software for solving many common scientific computing problems. Linear systems, least-square data fitting, nonlinear equations and systems, and optimization problems. Prerequisites: MATH 12003, 21001, and CS23021 or permission. Special fee \$3.33/cr. hr. subject to change.

**42202 Numerical Computing II (3)**

(Cross-listed with CS 42202) A continuation of MATH 42201. Topics include interpolation, numerical differentiation and integration, and numerical solution of ordinary differential equations. Prerequisites: MATH 32044 and CS 42201.

**45011 Differential Geometry (3)**

Analytic and metric differential geometry of curves and surfaces. Prerequisite: MATH 22005.

**45021 Euclidean Geometry (3)**

Geometry of Euclid extended to advanced topics of the triangle, quadrilaterals and circles; cross-ratio, groups, constructions, geometric generalizations; inversion. Prerequisite: MATH 21001 or permission of instructor.

**45022 Linear Geometry (3)**

Using transformations as a tool to study geometry and to differentiate between different kinds of geometry. Linear algebra methods applied to geometry. Prerequisite: MATH 21001 or permission.

**46001 Elementary Topology (3)**

Metric spaces, introduction to topological spaces, separation axioms. Prerequisite: MATH 22005.

**47001 Mathematical Logic and Set Theory (3)**

Axiomatic set theory, relations, development of real numbers, cardinal numbers, axiom of choice. Prerequisite: MATH 12003 or permission.

**47011 Theory of Numbers (3)**

Divisibility properties of the integers, prime numbers, congruences, quadratic reciprocity, Diophantine equations, number theoretic functions, simple continued fractions, rational approximations. Prerequisite: MATH 12003 or permission.

**47021 History of Mathematics (3)**

Survey from Babylonian and Egyptian mathematics to 20th century mathematics with emphasis on the development of algebra, geometry, calculus, and number theory. Prerequisite: 3 hours of mathematics beyond 22005 or permission.

**49995 Selected Topics in Mathematics and its Applications (2-4)**

(Repeated registration permitted) Various special courses will be announced in the Schedule of Classes under this course number with different section numbers. Prerequisite: Permission.

**49996 Individual Study (1-4)**

Prerequisite: Permission of instructor.

**49998 Research (1-5)**

Prerequisite: Permission.