

learn many new “kanji” as they improve their skills in written Japanese. Conversation practice will also be emphasized. Prerequisite: Japanese 215 or permission of the instructor.

217 Introduction to Modern Japanese Literature: 1868 to the Present (3). F A continuation of Japanese language study and an introduction to works written by major Japanese authors from 1868--when Japan opened itself to the rest of the world and entered the

modern era--to the present, as well as selected readings on Japanese history, society, and culture. Prerequisite: Japanese 216.

218 Further Studies in Modern Japanese Literature: 1868 to the Present (3). S This course builds on Japanese 217 and deals with literary texts of greater linguistic difficulty. It also includes further language study and selected readings on Japanese history, society, and culture. Prerequisite: Japanese 217.

Latin

See the Department of Classical Languages for a description of courses and programs of concentration in Latin.

Mathematics and Statistics

Professors J. Bradley, D. Brink, R. J. Ferdinands, E. Fife, T. Jager (chair), J. Koop, M. Stob, G. Talsma, G. Venema
*Associate Professors **C. Moseley, R. Pruim, J. Turner*
Assistant Professors M. Bolt, T. Scofield
Adjunct D. Laverell

MATHEMATICS MAJOR

All proposed major programs must be designed in consultation with a departmental advisor and approved by the Department of Mathematics and Statistics. Major programs must consist of a coherent package of courses intended to serve the student's interests and career goals and meet the following minimum requirements:

Mathematics 161 or 160

Mathematics 162

Mathematics 256

At least one of Mathematics 231, 243, and 261

Mathematics 361

Mathematics 351 or 355

At least two additional courses from among Mathematics 301, 305, 312, 329, 333, 335, 343, 344, 351, 355, 362, 365, and

380 totaling at least seven semester hours

An approved interim

Mathematics 391 (taken twice)

Required Cognate

Computer Science 108

Students with specific educational or career goals should take additional courses. Descriptions of a number of expanded programs—including programs in applied mathematics, pure mathematics, computational mathematics, statistics, and actuarial studies—are available in the *Mathematics Student Handbook*, which is available from any member of the Department and on the departmental webpage.

ELEMENTARY AND SECONDARY EDUCATION MATHEMATICS MAJOR

Students desiring to be certified to teach secondary mathematics must complete a major program that includes each of the courses listed below. Students are encouraged to take additional electives.

Mathematics 161 or 160
Mathematics 162
Mathematics 243
Mathematics 256
Mathematics 301
Mathematics 329
Mathematics 351
Mathematics 361
Mathematics 380
An approved interim
Mathematics 391 (taken twice)

Required Cognate

Computer Science 108

MATHEMATICS MINOR

All proposed minor programs must be designed in consultation with a departmental advisor. Minor programs must meet the following minimum requirements:

Mathematics 161 or 160
Mathematics 162
At least two of Mathematics 231, 232, 243, 256, and 261
At least two of Mathematics 301, 305, 312, 333, 335, 343, 344, 351, 355, 361, 362, 365, and 380 totaling at least seven semester hours

SECONDARY EDUCATION MATHEMATICS MINOR

Mathematics 161 or 160
Mathematics 162
Mathematics 256
Mathematics 243
Mathematics 301
Mathematics 329
Mathematics 361

Required Cognate

Computer Science 108

Prior to the teaching internship, students must have the approval of the department. Criteria for approval are found in the *Teacher Education Program Guidebook*, available in the Education Department. Directed teaching in secondary mathematics is available only during the fall semester.

ELEMENTARY EDUCATION MATHEMATICS MINOR

Mathematics 221
Mathematics 222
Mathematics 132 or Mathematics 161
Mathematics 110, an approved interim, or Mathematics 162
Mathematics 143 or Mathematics 243
IDIS 110
Three semester hours from IS 141, 151, 153, 171
(CPSC 108 or IS 271 may be substituted for the requirements on the two preceding lines)

The minor for elementary education should be chosen in consultation with a departmental advisor as choices for mathematics courses depend on the student's background.

GROUP MAJOR

A group major in science and mathematics meets the needs of some students, particularly those in professional programs. These majors are not appropriate for students who anticipate attending graduate school or who are in teacher education programs. Such group majors require twelve courses in the sciences and mathematics, ten of which must be from two departments with no fewer than four from either, with the remaining two courses chosen from a third department. The chairs of the three departments must approve each program of this type. The following two group majors are pre-approved. Other group majors may be arranged on an individual basis.

BUSINESS/MATHEMATICS GROUP MAJOR

Business 203
Business 204
Economics 221
Economics 222
Two Department Electives
Mathematics 161
Mathematics 162
Mathematics 256
Mathematics 261
Mathematics 343
Mathematics 344

Cognates

Information Systems 171
One from Information Systems 151, 153, 221, 141, 271, Computer Science 104, 108, or 112

MATHEMATICS/ECONOMICS GROUP MAJOR

Economics 221
Economics 222
One from Economics 323/325
One from Economics 324/326
Two department electives
Mathematics 161
Mathematics 162
Mathematics 256
Mathematics 261
Mathematics 343
Mathematics 344

Cognates

Information Systems 171
One from Information Systems 151, 153,
221, 141, 271, Computer Science 104,
108, or 112

HONORS PROGRAM

The departmental honors program leads to graduation with honors in mathematics or mathematics education. Beyond the requirements of the general honors program, these programs require further course work and a senior thesis. Details are available from the department. These programs require careful planning to complete, and students should normally apply for admission to the departmental honors program during their sophomore year at the same time that they submit a major concentration counseling sheet.

ADMISSION TO PROGRAM

A minimum grade of “C” (2.0) in one of Mathematics 231, 232, 243, 256, or 261 is required for admission to a program of concentration in the department.

THE MATHEMATICS CORE REQUIREMENT MAY BE MET BY ANY OF THE FOLLOWING

100, 143, 160, 161, or 221

COURSES

100 Mathematics in the Contemporary World (3). F and S. An introduction to the nature and variety of mathematics results and methods, mathematics models and their applications, and to the interaction between mathematics and culture. Not open to mathematics and natural science majors.

110 Pre-calculus Mathematics (4). F. A course in elementary functions to prepare students for the calculus sequence. Topics include the properties of the real number system, inequalities and absolute values, functions and their graphs, solutions of equations, polynomial functions, trigonometric functions, exponential, and logarithm functions. Prerequisite: Three years of college preparatory mathematics (excluding statistics courses).

132 Calculus for Management, Life, and Social Sciences (4). F and S. Functions, limits, and derivatives. Applications of derivatives to maximum-minimum problems, exponential and logarithmic functions, integrals, and functions of several variables. Not open to those who have completed Mathematics 161. Prerequisite: Mathematics 143 or permission of instructor.

143 Introduction to Probability and Statistics (4). F and S. An introduction to the concepts and methods of probability and statistics. The course is designed for students interested in the application of probability and statistics in business, economics, and the social and life sciences. Topics include descriptive statistics, probability theory, random variables and probability distributions, sampling distributions, point and interval estimation, hypothesis testing, analysis of variance, and correlation and regression.

156 Discrete Mathematics for Computer Science (4). F. An introduction to a number of topics in discrete mathematics that are particularly useful for work in computer science, including propositional logic, sets, functions, counting techniques, models of computation and graph theory. Applications in computer science. Prerequisite: Computer Science 108 or permission of the instructor.

159 Elementary Functions and Calculus (4). F. Mathematics 159 and 160 together serve as an alternative to Mathematics 161 for students who have completed four years of high school mathematics but who are not ready for calculus. Placement in Mathematics 159 or 161 is determined by a calculus readiness test that is administered to incoming first-year students during orientation. Topics include functions

and their graphs, polynomial functions, trigonometric functions, exponential and logarithmic functions, limits, and derivatives. Prerequisite: Four years of college preparatory mathematics (excluding statistics courses).

160 Elementary Functions and Calculus II (3). I. A continuation of Mathematics 159. Topics include derivatives, applications of derivatives, integrals, and applications of integrals. Historical and philosophical aspects of calculus are integrated with the development of the mathematical ideas, providing a sense of the context in which calculus was developed. Prerequisite: Mathematics 159.

161 Differential and Integral Calculus (4). F and S. This course serves as an introduction to calculus. Topics include functions, limits, derivatives, applications of derivatives, integrals, and applications of integrals. Historical and philosophical aspects of calculus are integrated with the development of the mathematical ideas, providing a sense of the context in which calculus was developed. Prerequisite: Either four years of college preparatory mathematics (excluding statistics courses) or Mathematics 110. A calculus readiness test is administered by the department during orientation and some students may be placed in Mathematics 159 on the basis of that test.

162 Techniques of Integration, Introduction to Infinite Series, and Multivariate Calculus (4). F and S, honors section. Techniques of integration; rectangular, cylindrical, and spherical coordinate systems; vectors; partial derivatives; multiple integrals; and an introduction to sequences and series. Prerequisite: Mathematics 160 or 161. Laboratory. First-year students with advanced placement credit for Mathematics 161 should normally enroll in section AP.

190 First-Year Seminar in Mathematics (1). F An introduction in seminar format to several different topics in mathematics not otherwise part of the undergraduate program. Topics vary by semester, but will include both classical and recent results and both theoretical and applied topics. The goals of the course are to acquaint students with the breadth of mathematics and to provide opportunity for students inter-

ested in mathematics to study these topics together. All first-year students interested in mathematics (regardless of prospective major program) are welcome to register. This course will be graded on a credit/no-credit basis.

201 Quantitative Methods for Management (4). F and S. Linear programming; basic concepts, spreadsheet modeling, applications. Network optimization, decision analysis, queuing, computer simulations. Prerequisite: Information Systems 171, Business 160, Mathematics 143. Open to first year students only with permission of instructor.

221 The Real Number System and Methods for Elementary School Teachers (4). F and S. This course provides prospective elementary school teachers with background needed for teaching elementary mathematics. Both content and methodology relevant to school mathematics are considered. Topics covered include the real number system and its sub-systems. Pedagogical issues addressed include the nature of mathematics and of mathematics learning and the role of problem solving and the impact of technology in the elementary school mathematics curriculum. Prerequisites: Not open to first year students except by permission of the instructor.

222 Geometry, Probability, Statistics, and Methods for Elementary School Teachers (4). F and S. This course is a continuation of Mathematics 221. Both content and methodology relevant to teaching geometry, probability, and statistics in elementary school are considered. Topics covered include basic geometric concepts in two and three dimensions, transformational geometry, measurement, probability, and descriptive and inferential statistics. Pedagogical issues addressed include the place of geometry, probability, and statistics in the elementary school curriculum, use of computers in mathematics, and the development of geometric and probabilistic thinking. Prerequisite: Mathematics 221 or permission of the instructor.

231 Differential Equations with Linear Algebra (4). F and S. An introduction to solutions and applications of first and second-order ordinary differential equations

including Laplace transforms, elementary linear algebra, systems of linear differential equations, numerical methods and non-linear equations. Prerequisites: Mathematics 162 and experience in computer programming.

232 Engineering Mathematics (4). F and S. A study of topics from vector calculus, linear algebra, and statistics that are useful to engineers. Topics include vector fields, line and surface integrals, Gaussian elimination and matrix factorization, vector spaces, linear independence and basis, orthogonal projection, least squares approximation, descriptive statistics, probability, statistical inference, and regression. Students may not receive credit for this course and any of Mathematics 243, 255, or 261. Prerequisite: Mathematics 231.

243 Statistics (4). S. Data analysis, data collection, random sampling, experimental design, descriptive statistics, probability, random variables and standard distributions, Central Limit Theorem, statistical inference, hypothesis tests, point and interval estimates, simple linear regression. Examples will be chosen from a variety of disciplines. Computer software will be used to display, analyze and simulate data. Prerequisite: Mathematics 162.

256 Discrete Structures and Linear Algebra (4). F and S. An introduction to mathematical reasoning, elementary number theory and linear algebra, including applications for computer science. Prerequisites: Computer Science 108, Mathematics 161 and Mathematics 156 or 162. (Computer Science 108 may be taken concurrently.)

261 Vector Calculus and Advanced Topics in Infinite Series (4). F Infinite series, Taylor series, curves and motion in space, functions of several variables, line and surface integrals, and vector calculus. Prerequisite: Mathematics 162.

301 The Foundations of Geometry (3). S. A study of Euclidean and hyperbolic geometries from an axiomatic viewpoint. Additional topics include transformations, and the construction of models for geometries. Prerequisite: Mathematics 256 or permission of the instructor.

305 The Geometry and Topology of Manifolds (4). F, odd years. An introduction to the study of manifolds, including both the geometric topology and the differential geometry of manifolds. The emphasis is on low-dimensional manifolds, especially curves and surfaces. Topics include the topology of subsets of Euclidean space, curves and surfaces in Euclidean space, the topological classification of compact connected surfaces, smooth curves and surfaces, curvature, geodesics, the Gauss-Bonnet Theorem and the geometry of space. Prerequisites: Vector Calculus (Mathematics 232 or 261) and Linear Algebra (Mathematics 231, 232, 256 or 355). Not offered 2006-2007.

312 Logic, Computability, and Complexity (4). F, even years. An introduction to first-order logic, computability and computational complexity. Topics covered include soundness and completeness of a formal proof system, computability and non-computability, and computational complexity with an emphasis on NP-completeness. Also listed as Computer Science 312. Prerequisite: Mathematics 256.

329 Introduction to Teaching Secondary School Mathematics (2). S. This course introduces prospective teachers to important curricular and pedagogical issues related to teaching secondary school mathematics. These issues are addressed in the context of mathematical topics selected from the secondary school curriculum. The course should be taken during the spring preceding student teaching. Prerequisite: A 300-level course in Mathematics.

333 Partial Differential Equations (4). F An Introduction to partial differential equations and their applications. Topics Include mathematical modeling with partial differential equations, nondimensionalization, orthogonal expansions, solution methods for linear initial and boundary-value problems, asymptotic expansions, and numerical solution of partial differential equations. Prerequisites: Mathematics 231 and either 261 or 232.

335 Numerical Analysis (4). S, odd years. Theory and practice of computational procedures Including principles of error analysis and scientific computation, root-find-

ing, polynomial Interpolation, splines, numerical Integration, applications to ordinary differential equations, computational matrix algebra, orthogonal polynomials, least square approximations, and other applications. Also listed as Computer Science 372. Prerequisites: Computer Science 104 or 108 and Mathematics 256 or 232.

343 Probability and Statistics (4). F Probability, probability density functions; binomial, Poisson, and normal distributions; central limit theorem, limiting distributions, sample statistics, hypothesis tests, and estimators. Prerequisite: Mathematics 231, 232, 256, or 261.

344 Mathematical Statistics (4). S. A continuation of Mathematics 343 including theory of estimation, hypothesis testing, non-parametric methods, regression analysis, and analysis of variance. Prerequisite: Mathematics 343.

351 Abstract Algebra (4). S. An Introduction to abstract algebraic systems, including groups, rings, and fields, and their applications. Prerequisite: Mathematics 361.

355 Advanced Linear Algebra (4). S, odd years. Vector spaces, linear transformations, eigenvalues and eigenvectors, inner product spaces, spectral theory, singular values and pseudoinverses, canonical forms, and applications. Prerequisite: Mathematics 256, or Mathematics 232, or both Mathematics 231 and 261.

359 Seminar in Secondary Teaching of Mathematics (3). F A course in perspectives on, principles of, and practices in the teaching of mathematics on the secondary level. This course must be taken concurrently with Education 346. The seminar provides a forum for the discussion of concerns that develop during directed teaching. This course is part of the professional education program and may not be included in the major or minor in mathematics.

361 Real Analysis I (4). F The real number system, sets and cardinality, the topology

of the real numbers, numerical sequences and series, real functions, continuity, differentiation, and Riemann Integration. Prerequisites: Two courses beyond Mathematics 162.

362 Real Analysis II (4). S, even years. A continuation of Mathematics 361. Topics from sequences and series of functions, measure theory, and Lebesgue integration. Prerequisite: Mathematics 361. Not offered 2006-2007.

365 Complex Variables (4). S. Complex numbers, complex functions, integration and the Cauchy integral formula, power series, residues and poles, and conformal mapping. Prerequisite: Mathematics 261 or 232.

380 Perspectives on Modern Mathematics (3). S, odd years. *Core: Integrative Studies.* This course explores the historical development of some of the basic concepts of modern mathematics. It includes an examination of significant issues and controversies, philosophical perspectives, and problems on which mathematicians have focused throughout history. Prerequisites: Mathematics 361, Biblical Foundations I or Theological Foundations I, DCM, and Philosophical Foundations.

390 Independent Study (1-4). F, I, and S. Independent study of topics of interest to particular students under supervision of a member of the department staff. Open to qualified students with permission of the department chair.

391 Colloquium (0). F and S. Meets weekly for an hour for the presentation of various topics in Mathematics, computer science, and related disciplines by students, faculty, and visiting speakers. Prerequisites: Two 200-level courses in mathematics.

395 Senior Thesis in Mathematics (1-4). F, I, and S. The course requirements include an expository or research paper and an oral presentation on a selected topic in mathematics. Open to qualified students with the permission of the chair.