MATHEMATICS (MATH)

Courses

MATH 41 BEGINNING ALGEBRA WITH REASONING SKILLS 4 Units
A course for those who need to strengthen their basic algebra and mathematical reasoning skills. Topics include properties of the real numbers, linear equations, exponents, polynomials, and systems of linear equations. Emphasis on solving problems in context. The course credits count toward the semester credit load and GPA, but are not included in the 120-credit graduation requirement.
PREREQ: APPROPRIATE SCORE ON THE UW MATH PLACEMENT TEST

MATH 49 WORKSHOP *Repeatable* 1 Units
Variable credit course offering with a defined topic. Repeatable with a change of topic.

MATH 93 SUPPORT FOR QUANTITATIVE REASONING 2 Units
This course is designed to enrich the MATH 139 Quantitative Reasoning course. It is dedicated to support students by identifying and addressing skills that require review as well as create a structure that will support student success and improve math study skills. In addition to the pursuit of algebraic skills essential for success in MATH 139 and subsequent college-level mathematics courses, students will engage in activities for understanding and reducing test anxiety and will create strategies to improve motivation, mindfulness, and mindset.
PREREQ: PLACEMENT INTO MATH 93

MATH 104 THE LOGIC OF CHESS 1 Units
A study of logic particularly as it is used in the game of chess and, most particularly, in chess strategy and the end game of chess. The rules are taught to those who are not already acquainted with the game.

MATH 124 SUPPORT FOR COLLEGE ALGEBRA 1 Units
This course is designed to enrich MATH 142. It is dedicated to supporting students by identifying and addressing skills that require review and creating a structure that will support student success and improve math study skills. In addition to pursuing algebraic skills essential for success in MATH 142 and subsequent college-level mathematics courses, students will engage in activities to improve motivation, mindfulness, and mindset.
PREREQ: (C OR BETTER IN (MATH 41 OR MAT 91 OR MAT 97 OR UWX MA091)) OR (PLACEMENT INTO MATH 124 AND MATH 142 TOGETHER)

MATH 139 QUANTITATIVE REASONING 3 Units
A quantitative reasoning course which includes topics from college algebra (such as functions, linear, exponential and logarithmic models), statistics, and probability. Emphasizes modeling, problem-solving and applications. Designed for students whose programs do not require further coursework in pre-calculus or calculus. Appropriate for students majoring and minoring in areas such as the arts, humanities, social sciences, business, and education.
PREREQ: C OR BETTER IN (MATH 41 OR MAT 91 OR MAT 97 OR MAT 103 OR MAT 105 OR UWX MA091) OR CONCURRENT ENROLLMENT IN MATH 93 OR PLACEMENT INTO MATH 139

MATH 140 MATHEMATICAL IDEAS 3 Units
Designed to give students a broad understanding and appreciation of mathematics. Includes topics not usually covered in a traditional algebra course. Topics encompass some algebra, problem solving, counting principles, probability, statistics, and consumer mathematics. This course is designed to meet the University Proficiency Requirement for students who do not wish to take any course having MATH 139 or MATH 142 as a prerequisite.
PREREQ: GRADE OF C OR BETTER IN MATH 41 OR CONCURRENT ENROLLMENT IN MATH 93 OR PLACEMENT INTO MATH 140

MATH 141 FUNDAMENTALS OF COLLEGE ALGEBRA 4 Units
A functional approach to algebra with emphasis on applications to different disciplines. Topics include linear, exponential, logarithmic, quadratic, polynomial and rational equations and functions, systems of linear equations, linear inequalities, radicals and rational exponents, complex numbers, variation. Properties of exponents, factoring, and solving linear equations are reviewed.
PREREQ: MATH 41 WITH A GRADE OF C OR BETTER OR WAIVER

MATH 142 COLLEGE ALGEBRA 4 Units
Study of polynomial, radical, rational, piecewise, exponential, and logarithmic functions, including basic graphs, transformations, inverses, and combining functions; solving equations and inequalities both algebraically and graphically is explored. Applications to other disciplines are used to enhance conceptual understanding.
PREREQ: (C OR BETTER IN (MATH 139 OR MAT 105 OR MAT 108)) OR (CONCURRENT ENROLLMENT IN MATH 124) OR (PLACEMENT INTO MATH 142) UNREQ: A STUDENT MAY EARN CREDIT FOR ONLY ONE OF MATH 142 OR MATH 152

MATH 143 FINITE MATHEMATICS FOR BUSINESS AND SOCIAL SCIENCES 3 Units
Mathematical preparation for the understanding of quantitative methods in management and social sciences. Topics include sets, relations, linear functions, interest, annuities, matrices, solution of linear systems by graphical, algebraic, Gauss-Jordan, and inverse methods, linear programming by graphical and simplex methods, counting and probability. College of Business and Economics majors must take this course on a conventional grade basis.
PREREQ: GRADE OF C OR BETTER IN MATH 139 OR MATH 141 OR MATH 142

MATH 147 MATHEMATICS IN EARLY CHILDHOOD LEARNING 4 Units
A study of topics in early childhood mathematics, including sets, numbers, operations, measurement, data, and geometry. The focus is on increasing conceptual understanding of mathematics, highlighting connections, and developing the ability to communicate mathematical knowledge. Problem-solving methods used by children will also be explored. Manipulatives, cooperative learning activities, and problem solving strategies are used throughout the course.
PREREQ: GRADE OF C OR BETTER IN MATH 139 OR MATH 141 OR MATH 142

MATH 148 MATHEMATICS FOR THE ELEMENTARY TEACHER I 3 Units
A study of topics in early childhood through early adolescence mathematics, including sets, fundamental operations of arithmetic, fundamental algorithms, and structural properties of arithmetic. The focus is on increasing conceptual understanding of mathematics, highlighting connections, and developing the ability to communicate mathematical knowledge. Problem-solving methods used by children will also be explored. Manipulatives, cooperative learning activities, and problem solving emphasized.
PREREQ: GRADE OF C OR BETTER IN MATH 139 OR MATH 141 OR MATH 142

MATH 149 MATHEMATICS FOR THE ELEMENTARY TEACHER II 3 Units
Topics in probability and statistics, with emphasis on descriptive techniques. Investigations in geometric figures, measurement, construction, transformations, congruent and similar geometric figures. Problem solving strategies, manipulatives, and cooperative learning activities are emphasized throughout the course.
PREREQ: MATH 147 WITH A GRADE OF C OR BETTER OR MATH 148 WITH A GRADE OF C OR BETTER

MATH 151 TRIGONOMETRY 3 Units
Study of trigonometric functions including basic graphs, transformations, and inverses; trigonometric functions are studied through the unit circle and right triangle approaches. Also studied are trigonometric identities, equations, and applications, including Law of Sines and Law of Cosines, as well as polar coordinates.
PREREQ: GRADE OF C OR BETTER IN MATH 142 OR DEPARTMENT CONSENT UNREQ: A STUDENT MAY EARN CREDIT FOR ONLY ONE OF MATH 151 OR MATH 152.

MATH 152 PRECALCULUS 5 Units
Study of polynomial, radical, rational, piecewise, exponential, logarithmic, and trigonometric functions, including basic graphs, transformations, inverses, and combining functions; solving equations and inequalities both algebraically and graphically is explored. In addition, trigonometric functions are studied through the unit circle and right triangle approaches. Also studied are vectors, trigonometric identities, trigonometric equations, and polar coordinates.
PREREQ: PLACEMENT INTO MATH 152 OR DEPARTMENT CONSENT UNREQ: A STUDENT MAY ONLY EARN CREDIT FOR ONE OF THE FOLLOWING: MATH 152 OR (MATH 142 AND MATH 151).

MATH 200 MATHEMATICS: FORM AND FUNCTION 1 Units
An introduction to abstract and applied mathematical thinking, including exploration of career opportunities in the mathematical sciences. Centered around the dual question of "What is mathematics, and what is it good for?", this course serves as a introduction to the mathematics major and minor and includes an overview of the different emphases within the major.
COREQ: MATH 253 (MAY BE COMPLETED PRIOR TO ENROLLMENT)

MATH 243 CALCULUS FOR BUSINESS AND SOCIAL SCIENCES 4 Units
A survey of calculus emphasizing business and social science applications. Topics covered include related algebra concepts and skills, limits, differentiation, max-min theory, exponential and logarithmic functions, and integration. Other topics included at instructor discretion.
PREREQ: MATH 142 WITH A GRADE OF C OR BETTER, OR MATH 143 WITH A GRADE OF C OR BETTER, OR MATH 152 WITH A GRADE OF C OR BETTER

MATH 248 TUTORING SEMINAR 1 Units
Tutoring methods and practice are discussed with a focus on inquiry-based learning. Students will be assigned as in-class tutors for courses such as quantitative reasoning and mathematics for elementary teachers in addition to weekly discussions.
PREREQ: C OR BETTER IN MATH 253

MATH 250 APPLIED CALCULUS SURVEY FOR BUSINESS AND SOCIAL SCIENCES 5 Units
An applied calculus course covering elementary analytic geometry, limits, differentiation, max-min theory, exponential and logarithmic functions, integration, functions of several variables, and elementary differential equations. Some computer topics may be included. A student may earn credit for only one of MATH 250 and MATH 253.
PREREQ: A GRADE OF C OR BETTER IN MATH 142 OR MATH 152 UNREQ: A STUDENT MAY ONLY EARN CREDIT FOR ONE OF THE FOLLOWING: MATH 250 OR MATH 253

MATH 253 CALCULUS AND ANALYTIC GEOMETRY I 5 Units
Review of algebraic and trigonometric functions, transcendental functions, limits, study of the derivative, techniques of differentiation, continuity, applications of the derivative, L' Hopital's Rule and indeterminate forms, the Riemann integral, Fundamental Theorem of Calculus, the substitution rule, and applications of the integral, including volumes of revolution and average value.
PREREQ: GRADE OF C OR BETTER IN (MATH 142 AND MATH 151) OR MATH 152 UNREQ: A STUDENT MAY ONLY EARN CREDIT FOR ONE OF THE FOLLOWING: MATH 250 OR MATH 253

MATH 254 CALCULUS AND ANALYTIC GEOMETRY II 4 Units
Techniques of integration, introduction to differential equations, parametric equations, and infinite sequences and series.
PREREQ: MATH 253 OR (MATH 250 AND MATH 151) OR (MATH 250 AND MATH 152), EACH WITH A GRADE OF C OR BETTER

MATH 255 CALCULUS AND ANALYTIC GEOMETRY III 4 Units
A course in multivariable calculus. Topics include: solid analytic geometry; vectors and vector functions; functions of several variables, including limits, continuity, partial and directional derivatives, gradient vectors, and Lagrange multipliers; multiple integrals in rectangular, cylindrical, and spherical coordinates; line and surface integrals; Green's Theorem, Stokes' Theorem, and the Divergence Theorem.
PREREQ: MATH 254 WITH A C OR BETTER

MATH 270 PROBLEM SOLVING FOR MATHEMATICS TEACHERS 3 Units
Students will learn a variety of problem solving strategies applicable in elementary and secondary school. The applications will cover many different areas of mathematics. Students will also practice solving challenging problems from various math competitions and learn to prepare students for such contests.
PREREQ: C OR BETTER IN (MATH 149 OR MATH) 253 UNREQ: A STUDENT MAY EARN CREDIT FOR ONLY ONE OF MATH 270 OR MATH 370

MATH 280 DISCRETE MATHEMATICS 3 Units
This course provides an introduction to mathematical proof, beginning with a discussion of formal logic. Topics include sets, functions, relations, number theory, combinatorics, and probability.
PREREQ: MATH 250 WITH A GRADE OF B OR BETTER OR MATH 253 WITH A GRADE OF C OR BETTER

MATH 281 PUTNAM COMPETITION AND PROBLEM SOLVING *Repeatable* 1 Units
Preparation for the William Lowell Putnam Competition. Includes advanced problem solving techniques in pure mathematics. Review of previous examination problems and related material. May be repeated for a total of four credits. Satisfactory/No Credit only.
PREREQ: MATH 253 OR CONSENT OF INSTRUCTOR COREQ: MATH 280 OR CONSENT OF INSTRUCTOR

MATH 296 SPECIAL STUDIES *Repeatable* 1-3 Units

MATH 298 INDEPENDENT STUDY *Repeatable* 1-3 Units
Study of a selected topic or topics under the direction of a faculty member. Repeatable. Department Consent required.

MATH 301 INTRODUCTION TO ANALYSIS 3 Units
A first course in real analysis. Topics include properties of the real numbers, convergence of sequences, monotone and Cauchy sequences, continuity, differentiation, the Mean Value Theorem, and the Riemann integral. Emphasis is placed on proof-writing and communicating mathematics.
PREREQ: MATH 254 WITH A GRADE OF C OR BETTER, AND MATH 280

MATH 333 EUCLIDEAN GEOMETRY 3 Units
The topics included in this course are foundations of two-dimensional Euclidean geometry and transformational geometry, with emphasis on topics most relevant for prospective mathematics teachers. The approach of the course is not a precise, axiomatic development, but rather emphasizes intuitive thinking, problem solving, and proof writing. The course includes an introduction to dynamic geometry software (such as Geometer's Sketchpad or GeoGebra).
PREREQ: MATH 270 OR MATH 280 OR MATH 370 UNREQ: A STUDENT MAY EARN CREDIT FOR ONE OF MATH 333 OR MATH 353 OR MATH 416

MATH 343 APPLIED PROBABILITY THEORY 3 Units
Sets and counting, probability spaces, discrete and continuous random variables, mathematical expectation, and discrete and continuous distributions with applications.
PREREQ: GRADE OF C OR BETTER IN MATH 250 OR MATH 253

MATH 346 THEORY OF INTEREST 3 Units
This course will cover the topics of interest theory listed in the Society of Actuaries/Casualty Actuarial Society syllabus for Exam FM/2. Topics include the time value of money, annuities, loans, bonds, general cash flows and portfolios, and immunization schedules.
PREREQ: MATH 254 WITH A C OR BETTER

MATH 352 INFINITE PROCESSES FOR THE ELEMENTARY TEACHER 3 Units
This course is primarily for pre-service elementary and middle school teachers. Students will be introduced to the concepts of calculus, which include infinite processes, limits, and continuity. In addition, derivatives and integrals and their relationships to change and area will be covered.
PREREQ: GRADE OF C OR BETTER IN (MATH 142 AND 151) OR MATH 152

MATH 355 MATRICES AND LINEAR ALGEBRA 3 Units
Systems of linear equations, matrices and determinants, finite dimensional vector spaces, linear dependence, bases, dimension, linear mappings, orthogonal bases, and eigenvector theory. Applications stressed throughout.
PREREQ: GRADE OF C OR BETTER IN MATH 253 OR (MATH 250 AND (MATH 151 OR MATH 152))

MATH 359 PROBABILITY & STATISTICS FOR TEACHERS 3 Units
An introduction to probability and statistical theory for teachers. Topics covered include counting techniques, basic probability theory, discrete and continuous distributions, the Central Limit Theorem, simulation, randomization, and statistical inference.
PREREQ: (C OR BETTER IN (STAT 230 AND MATH 253)) OR INSTRUCTOR CONSENT

MATH 361 DIFFERENTIAL EQUATIONS 3 Units
Ordinary differential equations: general theory of linear equations, special methods for nonlinear equations including qualitative analysis and stability, power series and numerical methods, and systems of equations. Additional topics may include transformation methods and boundary value problems. Applications stressed throughout.
PREREQ: MATH 254 WITH A C OR BETTER

MATH 375 HISTORY OF MATHEMATICS 3 Units
A study of the development of mathematical notation and ideas from prehistoric times to the present. Periods and topics will be chosen corresponding to the backgrounds and interests of the students.
PREREQ: C OR BETTER IN ((MATH 142 AND MATH 151) OR MATH 152) OR INSTRUCTOR CONSENT

MATH 381 MATHEMATICAL MODELING AND SIMULATION 3 Units
Modeling involving formulation of deterministic, stochastic and rule-based models and computer simulation in order to make predictions. Topics may include unconstrained and constrained growth models, equilibrium and stability, force and motion, predator-prey model, enzyme kinetics, data-driven models, probability distributions, Monte Carlo simulations, random walk, diffusion, cellular automaton simulations, and high performance computing.
PREREQ: MATH 254 WITH A GRADE OF C OR BETTER AND MATH 355

MATH 415 MODERN ALGEBRA AND NUMBER THEORY FOR THE ELEMENTARY TEACHER 3 Units
An introduction to modern algebra with special emphasis on the number systems and algorithms which underlie the mathematics curriculum of the elementary school. Topics from logic, sets, algebraic structures, and number theory.
PREREQ: MATH 270 OR MATH 370 OR INSTRUCTOR CONSENT

MATH 417 NUMBER THEORY 3 Units
A study of the properties of integers, representation of integers in a given base, properties of primes, arithmetic functions, module arithmetic. Diophantine equations and quadratic residues. Consideration is also given to some famous problems in number theory.
PREREQ: MATH 280 OR MATH 415 OR CONSENT OF INSTRUCTOR

MATH 421 MATHEMATICS FOR HIGH SCHOOL TEACHERS I 3 Units
The course revisits the high school curriculum from an advanced perspective. The focus is on deepening understanding of concepts, highlighting connections and solving challenging problems. The mathematical content includes number systems, functions, equations, integers, and polynomials. Connections to geometry are emphasized throughout the course.
PREREQ: MATH 280, MATH 301 AND AT LEAST AN ADDITIONAL 3 CREDITS IN UPPER LEVEL MATH

MATH 422 MATHEMATICS FOR HIGH SCHOOL TEACHERS II 3 Units
The course continues the exploration of the high school curriculum from an advanced perspective that was started in MATH 421. The focus is on deepening understanding of concepts, highlighting connections and solving challenging problems. The mathematical content includes congruence, distance, similarity, trigonometry, area, and volume. Connections to algebra are emphasized throughout the course.
PREREQ: MATH 333

MATH 431 TOPOLOGY 3 Units
An introduction to point-set topology, including such topics as topological spaces, mappings, connectedness, compactness, separation axioms, metric spaces, complete spaces, product spaces and function spaces.
PREREQ: MATH 255 AND EITHER MATH 280 OR CONSENT OF INSTUCTOR

MATH 433 NON-EUCLIDEAN GEOMETRY 3 Units
Axiomatic development of finite geometries: 4-point, Fano's, and Young's geometries. Poincare models for hyperbolic geometry, with emphasis on similarities and differences with Euclidean Geometry (including Saccheri and Lambert quadrilaterals, and their properties). Elliptic geometry, contrasted with Euclidean and Hyperbolic geometries. The unit on projective geometry includes the concept of duality, Desargues' theorem, and projective transformations.
PREREQ: MATH 333 UNREQ: A STUDENT MAY EARN CREDIT FOR ONLY ONE OF MATH 353 OR MATH 433

MATH 442 MATHEMATICAL STATISTICS 4 Units
This course will cover moment generating functions; multivariate probability distributions including moments of linear combinations of random variables and conditional expectation; functions of random variables; sampling distributions and the Central Limit Theorem; the theory and properties of estimation; confidence intervals; and the Neyman-Pearson Lemma, likelihood ratio tests and common tests of hypotheses.
PREREQ: MATH 255 WITH A GRADE OF C OR BETTER AND MATH 343 WITH A GRADE OF C OR BETTER

MATH 450 GRAPH THEORY 3 Units
This course will examine basic concepts and applications of graph theory. Topics covered will be selected from trees, connectivity, paths and cycles, coloring, matching and covering problems, digraphs, and network flows.
PREREQ: MATH 280 OR CONSENT OF INSTRUCTOR

MATH 452 INTRODUCTION TO ABSTRACT ALGEBRA 3 Units
An introductory survey of abstract algebra and number theory with emphasis on the development and study of the number systems of integers, integers mod n, rationals, reals, and complex numbers. These offer examples of and motivation for the study of the classical algebraic structures of groups, rings, integral domains and fields.
PREREQ: MATH 280 OR CONSENT OF INSTUCTOR
UNREQ: MATH 415 AND MATH 452

MATH 453 ABSTRACT ALGEBRA 3 Units
This course is a continuation of MATH 452 with emphasis on ring and field theory. Topics include a review of group theory, polynomial rings, divisibility in integral domains, vector spaces, extension fields, algebraic extension fields, finite fields, etc.
PREREQ: MATH 355 AND MATH 452

MATH 458 APPLIED MATHEMATICAL ANALYSIS 3 Units
Selected topics in ordinary differential equations: series solutions, stability, transform methods, special functions, numerical methods, vector differential calculus, line and surface integrals.
PREREQ: MATH 361

MATH 459 PARTIAL DIFFERENTIAL EQUATIONS 3 Units
Fourier analysis, partial differential equations and boundary value problems, complex variables, and potential theory.
PREREQ: MATH 361

MATH 463 COMPLEX VARIABLES 3 Units
This course is a study of the algebra and geometry of complex numbers, the properties of analytic functions, contour integration, the calculus of residues and the properties of power series.
PREREQ: MATH 255

MATH 464 ADVANCED CALCULUS 3 Units
This course presents a rigorous treatment of the differential and integral calculus of single variable functions, convergence theory of numerical sequences and series, uniform convergence theory of sequences and series of functions, metric spaces, functions of several real variables, and the inverse function theorem. This course contains a writing component.
PREREQ: MATH 301 OR INSTRUCTOR CONSENT

MATH 471 NUMERICAL ANALYSIS 3 Units
Emphasis on numerical algebra. The problems of linear systems, matrix inversion, the complete and special eigenvalue problems, solutions by exact and iterative methods, orthogonalization, gradient methods. Consideration of stability and elementary error analysis. Extensive use of microcomputers and programs using a high level language. This course contains a writing component.
PREREQ: MATH 355 AND (COMPSCI 170 OR COMPSCI 172 OR COMPSCI 174 OR COMPSCI 220 OR COMPSCI 221 OR COMPSCI 222)

MATH 474 DYNAMICAL SYSTEMS & CHAOS 3 Units
An analytic, geometric, and intuitive study of continuous and discrete low-dimensional nonlinear dynamical systems. The basic notions of stability, bifurcations, chaotic systems, strange attractors, and fractals are examined. Specific applications will be taken from diverse fields such as Biology, Chemistry, Economics, Engineering, and Physics.
PREREQ: MATH 361 WITH A C OR BETTER

MATH 490 WORKSHOP *Repeatable* 1-3 Units
Variable topics. Group activity oriented presentations emphasizing `hands on` and participatory instructional techniques.

MATH 492 FIELD STUDY *Repeatable* 1-3 Units
A study for which data is obtained or observations are made outside the regular classroom. Repeatable. Instructor Consent required.

MATH 493 MATH INTERNSHIP *Repeatable* 1-3 Units

MATH 494 SEMINAR *Repeatable* 2 Units
Variable topics. Group activity. An advanced course of study in a defined subject matter area emphasizing a small group in intense study with a faculty member. Repeatable. Instructor Consent required.

MATH 496 SPECIAL STUDIES *Repeatable* 1-3 Units
Variable topics. Group activity. Not offered regularly in the curriculum but offered on topics selected on the basis of timeliness, need, and interest, and generally in the format of regularly scheduled Catalog offerings. Repeatable three times maximum in 6 years. Instructor Consent required.

MATH 497 EXCHANGE STUDY *Repeatable* 1-12 Units
Variable topics

MATH 498 INDEPENDENT STUDY *Repeatable* 1-5 Units
Study of a selected topic or topics under the direction of a faculty member. Repeatable. Department Consent required.

MATH 498R INDEPENDENT STUDY - UNDERGRADUATE RESEARCH *Repeatable* 1-3 Units
Study of a selected topic or topics under the direction of a faculty member. Repeatable. Department Consent required.

MATH 499 PROJECT FOR MAJORS 1 Units
This course is designed to give students experience and to improve their skill in reading, writing, and understanding mathematics by requiring them to research one or more mathematical topics and then write a report about their activities and discoveries. The focus is on the learning and communication of mathematics: how to read with understanding, write with clarity and precision, and in the process discover how writing can aid in understanding.
PREREQ: JUNIOR/SENIOR STATUS OR CONSENT OF INSTRUCTOR