Department of Mathematics, Physics, and Statistics

Mission Statement

The Department of Mathematics, Physics, and Statistics (http://www.apu.edu/clas/mathphysics/) at Azusa Pacific University:

1. Offers undergraduate programs in mathematics, applied mathematics, physics, and statistics, as well as a single subject waiver for a teaching credential in mathematics;
2. Provides General Education (http://catalog.apu.edu/academics/general-education/) mathematics and science courses consistent with the outcomes of a liberal arts education;
3. Prepares students for graduate study or success in their chosen careers; and
4. Offers a Master of Science in Applied Statistics and Data Science (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/applied-statistics-and-analytics-ms/) degree program.

Math and Physics Fellowships

Each year, the Department of Mathematics, Physics, and Statistics awards fellowships (https://www.apu.edu/clas/mathphysics/opportunities/fellowships/) to a select number of incoming and returning students. For more information, contact the department at (626) 815-6470 or mathphysics@apu.edu.

Programs

Majors

- Applied Mathematics (BS) (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/applied-mathematics-bs/)
- Mathematics (BA) (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/mathematics-ba/)
- Mathematics (BA) with Integrated Single Subject (Math) Teaching Credential (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/mathematics-ba/mathematics-ba-with-integrated-bachelors-credential/)
- Mathematics (BS) (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/mathematics-bs/)
- Physics (BS) (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/physics-bs/)

Minors

- Data Science (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/data-science-minor/)
- Mathematics (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/mathematics-minor/)
- Physics (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/physics-minor/)
- Statistics (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/statistics-minor/)

Master’s

- Master of Science in Applied Statistics and Data Science (http://catalog.apu.edu/academics/college-liberal-arts-sciences/math-physics-statistics/applied-statistics-and-analytics-ms/)

Math Placement

Mathematics Placement

APU uses the ALEKS PPL (https://www.apu.edu/academic-success/services/testing/math/about-aleks/) system to determine the best initial math placement for most students who need to take a math course (whether to satisfy the General Education Quantitative Literacy requirement or a major or minor requirement). Students who need to use ALEKS (https://www.apu.edu/academic-success/services/testing/math/using-aleks/) are encouraged to take an initial diagnostic assessment (https://www.apu.edu/academic-success/services/testing/math/start-aleks/) at home and then to work in their personalized Prep and Learning Module (https://www.apu.edu/academic-success/services/testing/math/prep-learning-module/) to review. They will then be able to take the assessment again (up to four times total) in order to achieve their best possible score.

Math Course Prerequisites

Prerequisites for common math courses are as follows:

Course(s)	Prerequisite(s)
MATH 90: Foundations of Mathematical Reasoning	ALEKS 15-29
MATH 95: Intermediate Algebra	ALEKS 30-44 or MATH 90
MATH 99: Self-Paced Mathematics Lab	ALEKS 0-29
MATH 115: Mathematics in Society MATH 130: Introduction to Statistics	ALEKS 30-100 or MATH 90
MATH 110: College Algebra UNRS 299: Statistics and Data Management for Nursing and Health Care	ALEKS 45-100 or MATH 95
MATH 149: Fundamentals of Precalculus MATH 150: Precalculus	ALEKS 60-100 or MATH 110
MATH 151: Applied Calculus I	ALEKS 65-100 or B- or better in MATH 110
MATH 165: Calculus I	ALEKS 75-100 or MATH 149 (which may be taken concurrently) or MATH 150

Math Test Score Equivalents

The table below shows how various test scores translate into APU math placement and/or course credit:

Scores	Results
• SAT Math (640 or higher on NEW version) • SAT Math (620 or higher on OLD version) • ACT Math (27 or higher) • High School Calculus (at least one semester with a grade of B or higher) • High School Precalculus (at least one semester with a grade of A- or higher)	Treated as if you have passed MATH 110 College Algebra at the level of B- or higher
• CLEP College Algebra, Precalculus, or Calculus (50) • IB Mathematics (5, 6, or 7) • AP Calculus AB or BC (3, 4, or 5)	Treated as if you have passed MATH 110 College Algebra at the level of B- or higher; credit granted
• AP Statistics (3, 4, or 5)	Credit granted for MATH 130 Introduction to Statistics
• ALEKS (65-100)	Treated as if you have passed MATH 110 College Algebra at the level of a B- or higher
• ALEKS (60-64)	Treated as if you have passed MATH 110 College Algebra at the level of C or higher (fails to meet the grade minimum of B- required as a prerequisite for CHEM 151 or to apply to any of the majors in the School of Business and Management other than the BA in Business Management)

Courses

MATH 90, Foundations of Mathematical Reasoning, 3 Units

This course prepares students for MATH 95 Intermediate Algebra, MATH 115 Mathematics in Society, or MATH 130 Introduction to Statistics. Topics include proportional reasoning; financial decision making; chance, risk, and probability; and algebraic modeling. Students practice reading, analyzing, and writing about quantitative texts; using spreadsheets to make efficient calculations; and solving algebraic equations to make predictions and decisions. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.

Prerequisite: An appropriate score on the APU mathematics placement assessment.

MATH 95, Intermediate Algebra, 3 Units

This course prepares students for the General Education Quantitative Literacy courses. Topics include linear graphs, mathematical models, systems of equations in two and three variables, multiplying and factoring polynomial functions, rational and radical expressions and functions, complex numbers, quadratic equations, and mathematical modeling with quadratic functions. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.

Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment

MATH 99, Self-paced Mathematics Lab, 1 Unit

This course is an alternative to MATH 90 for students who prefer an individualized developmental math experience. An adaptive online learning system enables students to skip topics they have already mastered and work at their own pace on the topics they need to learn, with support from a faculty member. The goal is to help students test out of MATH 90 in order to accelerate their path toward a General Education Quantitative Literacy course. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.
Prerequisite: ALEKS math placement score of 0-29 (or no ALEKS score).

MATH 110, College Algebra, 3 Units

This course offers a study of basic college algebra, including various elementary functions (linear, polynomial, rational, radical, exponential, and logarithmic), their properties and graphs, and equations and systems of equations. Emphasis is on using algebraic concepts to model and analyze real-world phenomena. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 95 or an appropriate score on the APU mathematics placement assessment.

MATH 115, Mathematics in Society, 3 Units

This course helps students make sense of quantitative information commonly encountered in everyday life in society. Students use mathematical methods and spreadsheets to analyze data from real newspaper articles in order to deepen their understanding of societal issues and personal financial management. Mathematical topics include estimation, unit conversions, percentages, indices, weighted averages, statistical summaries, linear and exponential models, and probabilities. These tools are used to analyze issues such as carbon footprints, crime rates, currency conversions, taxes, minimum wages, inflation, grade-point averages, salary distributions, electricity bills, climate change predictions, interest and depreciation, gambling, insurance, screening for diseases, and DNA evidence. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment.

MATH 130, Introduction to Statistics, 3 Units

This course is an introduction to the basic concepts and practices of statistics, including frequency distributions; graphs; central tendency; variation; probability; binomial, normal, t, and chi-square distributions; confidence intervals; hypothesis testing; correlation; regression; and ANOVA. *Meets the General Education Requirement: Quantitative Literacy (Math).*
Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment.

MATH 149, Fundamentals of Precalculus, 1 Unit

This course is a condensed alternative to MATH 150 designed for biology, biochemistry, and chemistry majors. Topics include circle trigonometry and sinusoidal functions, right-triangle trigonometry, and trigonometric equations and identities, as well as a brief review of exponential and logarithmic equations.
Prerequisite: MATH 110 or an appropriate score on the APU mathematics placement assessment. Only students with a declared major or interest in biology, biochemistry, or chemistry are permitted to register for this class.

MATH 150, Precalculus, 3 Units

This course prepares students for the calculus sequence. Topics include number systems, analytic geometry, elementary function theory (including logarithmic and trigonometric functions), and basic proof techniques.
Prerequisite: MATH 110 or an appropriate score on the APU mathematics placement assessment

MATH 151, Applied Calculus I, 3 Units

This course is an introduction to the calculus of a single variable, with a focus on applications. Topics include elementary functions (linear, exponential, logarithmic, power, and periodic), differentiation, and optimization.
Prerequisite: B- or better in MATH 110, or an appropriate score on the APU mathematics placement assessment.

MATH 165, Calculus I, 3 Units

Students in this course learn the theory and applications of the derivative, a mathematical tool used to calculate instantaneous rates of change. Topics include limits, continuity, interpretation and computation of derivatives, shapes of graphs, optimization, related rates, and parametric equations.
Prerequisite: MATH 150 or an appropriate score on the APU mathematics placement assessment or MATH 149 (May be taken concurrently)

MATH 166, Calculus II, 3 Units

Students in this course learn the theory and applications of the integral, a mathematical tool used to calculate the net change in a quantity over time. Topics include the definite integral, antiderivatives, the Fundamental Theorem of Calculus, integration techniques and applications, area and volume, arc length and surface area, and polar coordinates. The course concludes with a brief introduction to differential equations.
Prerequisite: C- or better in MATH 165

MATH 167, Sequences and Series, 1 Unit

This course introduces the powerful method of representing a function as a "polynomial of infinite degree." Topics include sequences and series, tests for convergence, power series, intervals of convergence, Taylor series, and applications.
Prerequisite: MATH 166 (May be taken concurrently)

MATH 199, Calculus Fundamentals for Statistics, 1 Unit

This course introduces fundamental topics in calculus required for understanding statistical theory and methods, including the interpretation of derivatives and integrals, rules for single-variable differentiation and integration, applications to optimization, moments and areas, and basic multivariable differentiation and integration.
Prerequisite: Acceptance into M.S. in Applied Statistics and Analytics program.

MATH 201, Mathematics Concepts for Elementary Teachers, 3 Units

The course provides the foundations of modern mathematics needed by the elementary school teacher. It is not a methods course, but a prerequisite to the Multiple-Subject Teaching Credential Program. This course does not count toward a mathematics major or minor.
Prerequisite: MATH 110 or equivalent

MATH 250, Data Analysis, 3 Units

This course features hands-on experience using statistical tools to answer real-world questions. Emphasis is on analysis of actual data using statistical software. Statistical topics include numerical/graphical summaries, measures of association, and statistical techniques including chi-square tests, t-tests, ANOVA, and regression. Focus is on interpretation, not calculation.
Prerequisite: MATH 130 or MATH 361

MATH 268, Multivariable Calculus, 3 Units

Students in this course learn about the calculus of functions of several variables. Topics include surfaces and contour diagrams, vectors, partial and directional derivatives, optimization and Lagrange multipliers, and multiple integration in rectangular, polar, cylindrical, and spherical coordinate systems.
Prerequisite: C- or better in MATH 166

MATH 269, Vector Calculus, 2 Units

Students in this course learn about the calculus of vector fields, leading to several higher-dimensional versions of the Fundamental Theorem of Calculus. Topics include parametrized curves; vector fields and flow; line integrals, gradients, and path-independence; Green's Theorem; divergence, flux integrals, and the Divergence Theorem; curl and Stokes' Theorem; and parametrized surfaces and change of coordinates.
Prerequisite: C- or better in MATH 268

MATH 270, Ordinary Differential Equations, 4 Units

This course is an introduction to ordinary differential equations and their applications. Topics include first- and second-order equations, Laplace transform, systems of differential equations, phase plane analysis, and introduction to numerical methods.
Prerequisite: MATH 268, or B- or better in MATH 166.

MATH 280, Discrete Mathematics and Proof, 3 Units

This course is a rigorous introduction to discrete mathematics with an emphasis on problem solving and proof writing, preparing students to construct valid mathematical arguments in upper-division courses. Topics include mathematical logic and set theory; direct and indirect proof; proofs with conjunctions, disjunctions, and quantifiers; relations; equivalence relations and partitions; functions and invertibility; and mathematical induction. Lecture, 3 hours; Discussion, 1 hour.
Prerequisite: MATH 165

MATH 290, Linear Algebra, 3 Units

An introduction to matrix algebra, vector spaces, and linear transformations. Topics include systems of linear equations, subspaces, linear independence, bases and dimension, abstract vector spaces, orthogonality, least-squares methods, inner product spaces, determinants, eigenvalues, and diagonalization.
Prerequisite: MATH 268 or MATH 280

MATH 295, Applied Linear Algebra, 3 Units

This course is an introduction to the analysis of numerical computations in linear algebra, including solutions of linear systems, QR decomposition, computation of eigenvalues and eigenvectors, and singular value decomposition.
Prerequisite: MATH 166

MATH 299, Linear Algebra Fundamentals for Statistics, 1 Unit

This course introduces fundamental topics in linear algebra required for statistical courses, including linear and generalized linear models, vectors and matrices, basic matrix operations, methods to solve linear systems, LU/QR decomposition, singular value decomposition, and computation of eigenvalues and eigenvectors.
Prerequisite: Acceptance into M.S. in Applied Statistics and Analytics program.

MATH 301, Mathematics for Secondary Teachers, 3 Units

A survey of the foundations of mathematics essential to the secondary school teacher. This course integrates secondary mathematics concepts with problem-solving strategies and technology. Students expand on their understanding of core math concepts, evaluate lesson plans used in secondary school mathematics, discuss and reflect on effective mathematics pedagogy, analyze readings in the field, engage in collegial interactions with the instructor and fellow students, and develop a repertoire of classroom-tested lessons that can be used in a high school classroom.

MATH 311, Teaching and Learning in STEM, 2 Units

Students in this course learn about the fundamentals of effective STEM teaching, including common challenges for STEM learners, active engagement strategies, assessment techniques, supporting diverse learners, designing assignments, and planning courses and lessons.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 151, PHYC 161, or equivalent

MATH 312, STEM Education Research Seminar, 1 Unit

Students identify challenges for effective STEM education that they observe during their experiences as STEM students and in STEM teaching support roles. Using readings drawn from the STEM education research literature, students identify and evaluate solutions to these challenges.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 151, PHYC 161, or instructor permission

MATH 313, STEM Teaching Practicum, 1 Unit

This course is intended for students serving in teaching support roles for STEM courses, including Learning Assistants, Teaching Assistants, and tutors. Students observe and reflect on effective STEM teaching practices and assist learners in engaging with and understanding course content.
Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 151, PHYC 161, or instructor permission

MATH 340, Geometry, 3 Units

This course is a study of Euclidean and hyperbolic geometries and their transformations and models. Students learn to write proofs within an axiomatic system and to form conjectures using interactive geometry software.
Prerequisite: MATH 166

MATH 350, Statistical Models, 3 Units

A study of investigative statistics emphasizing the process of data collection and data analysis relevant for science, social science, and mathematics students. The course incorporates case studies from current events and interdisciplinary research, taking a problem-based approach to learn how to determine which statistical techniques are appropriate. Topics include nonparametric tests, designing an experiment, multiple regression models, and Bayesian data analysis. Ethics in data analysis and reporting will be considered from a Christian perspective. Additionally, the course includes learning to program using a statistical software package.
Prerequisite: MATH 250

MATH 361, Introduction to Modeling with Probability, 3 Units

This course is an introduction to probability models used in statistics and data analysis. Topics include basic axioms of probability, random variables, probability distributions, expected values, and probability distribution theory.
Prerequisite: MATH 166

MATH 362, Mathematical Statistics, 3 Units

This course is an introduction to descriptive and inferential statistics used in data analysis. Topics include random sampling, parameter estimation, hypothesis testing and goodness of fit, summarizing data, and comparing samples.
Prerequisite: MATH 361 or STAT 501

MATH 370, Partial Differential Equations, 3 Units

This course is an introduction to Fourier analysis and analytical techniques for solving partial differential equations, with application to physical phenomena.
Prerequisite: MATH 270

MATH 375, Dynamical Systems, 3 Units

An introduction to phase plane analysis of first order differential equations and to bifurcations in continuous and discrete systems, with application to various branches of science.
Prerequisite: MATH 270

MATH 390, Number Theory, 3 Units

A study of elementary number theory, with an overview of the history of mathematics. Number theory topics include primes, divisibility, factorization, Diophantine problems, residue systems, theorems of Fermat and Euler, and continued fractions.
Prerequisite: MATH 280

MATH 400, Abstract Algebra, 3 Units

An introduction to groups and rings. Group theory topics include subgroups, cyclic groups, permutation groups, cosets and normal subgroups, factor groups, and homomorphisms. Ring theory topics include subrings and ideals, integral domains and fields, factor rings, and homomorphisms.
Prerequisite: MATH 280 with a C- or better

MATH 450, Real Analysis, 3 Units

This course is an advanced study of the real number system. Topics include completeness, convergence of sequences and series, topology of the real line, continuity, the Intermediate Value Theorem, differentiation, and the Mean Value Theorem.
Prerequisite: MATH 167 and a C- or better in MATH 280

MATH 451, Data Visualization, 3 Units

This course introduces students to the field of data visualization. Students learn basic visualization design and evaluation principles, and also how to acquire, parse, and analyze data sets using various data visualization software tools. Data types covered in the course include multivariate, temporal, text-based, geospatial, and network/graph-based.
Prerequisite: MATH 130

MATH 455, Numerical Analysis, 3 Units

Numerical and approximation methods are covered, including solutions of functions in single and multi-variables, interpolation, numerical differentiation and integration, and numerical methods for differential equations. Applications are programmed using an appropriate language.
Prerequisite: MATH 167, MATH 295, and CS 120

MATH 460, Topology, 3 Units

An introduction to topological spaces and their applications. Topics include bases, interior closure, subspace, product, and quotient topologies, continuity and homeomorphisms, metric spaces, connectedness, and compactness, with application to genetics, geography, robotics, and error-correcting codes. Additional topics chosen from homotopy theory, knot theory, and compact surfaces.
Prerequisite: MATH 450

MATH 470, Complex Analysis, 3 Units

This course is an introduction to the calculus of functions of one complex variable. Topics include elementary functions, limits, differentiability, series, contour integrals, Cauchy's theorem, conformal mapping, and selected applications.
Prerequisite: MATH 167 and MATH 268

MATH 480, Writing 3: Mathematical Reading, Writing, and Presentation, 3 Units

In this seminar course, students critically analyze journal articles in the field, receive writing instruction, write research and argumentative papers, and prepare effective mathematical presentations. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Prerequisite: Junior or senior standing, Writing 2.

MATH 492, Ethics in Data Analytics, 2 Units

The availability and use of data has led to tremendous opportunities. Businesses mine data to gain a competitive advantage, and healthcare organizations use it to help improve medical decision making. The use of data, however, has led to potential abuses. This course explores ethical issues in big data analytics, including issues surrounding collection, use, and reporting of data, and considers them from a Christian worldview.

MATH 495, Advanced Topics in Mathematics, 1-3 Units

This course engages students in focused study of an advanced topic which is not covered in the regular curriculum. The topic varies from semester to semester based on student interest. Possible topics include differential geometry, combinatorics, mathematical modeling, advanced linear algebra, game theory, cryptology, etc. This course may be taken more than once as the topic changes.
Prerequisite: Prerequisite(s) will vary depending upon the topic.

MATH 496, Mathematics Senior Seminar, 3 Units

In this culminating mathematics seminar, students wrestle with an outward-focused question - "How can I apply what I have learned in order to make a difference in the world?" - as well as an inward-focused question - "How can I develop the strength of character that will sustain me in living a life of mission?" Through research and reflection, students develop personal vision for how they will deploy their mathematical skills to do God's work in the world. At the same time, students engage with readings, seminar discussions, and spiritual practices that support the long-term growth of character and virtue. *Meets the General Education Requirement: Integrative and Applied Learning.*
Prerequisite: MATH 250, MATH 480 (waived for Honors College students), and senior standing.

MATH 497, Readings, 1-4 Units

This is a program of study concentrating on assigned readings, discussions, and writing arranged between and designed by a student of upper-division standing and a full-time professor. An independent study fee is assessed for each enrollment in this class.

MATH 498, Directed Research, 1-4 Units

This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log, writing, and seminar presentation within the department or in a university research symposium. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class.
Prerequisite: Junior or Senior Standing

MATH 499, Thesis/Project, 1-4 Units

This is a senior-level "capstone" type of independent study/research experience, involving the student in a unique project with a sophisticated level of research, synthesis, analysis, and communication. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying readings, log, instructor discussions, and writing of summary analysis and conclusions. The thesis or project may result in formal thesis, published article, or electronic media. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class.
Prerequisite: Upper-division writing intensive course or instructor consent; and junior or senior standing

PRMA 90, Foundations of Mathematical Reasoning, 3 Units

This course prepares students for Intermediate Algebra, Mathematics in Society, or Introduction to Statistics. Topics include proportional reasoning; experimental design; graphical, tabular, and numerical presentations of data; chance, risk, and probability; and algebraic modeling. Students practice displaying, summarizing, and analyzing data; computing and interpreting probabilities; and solving algebraic equations to make predictions and decisions. This course does not meet the General Education Quantitative Literacy requirement and does not count toward total units needed for graduation.

PRMA 110, College Algebra, 3 Units

This course offers a study of basic college algebra, including various elementary functions (linear, polynomial, rational, radical, exponential, and logarithmic), their properties and graphs, and equations and systems of equations. Emphasis is on using algebraic concepts to model and analyze real-world phenomena. *Meets the General Education Requirement: Quantitative Literacy (Math).*

Prerequisite: MATH 95 or an appropriate score on the APU mathematics placement assessment.

PRMA 130, Introduction to Statistics, 3 Units

This course is an introduction to the basic concepts and practices of statistics, including frequency distributions; graphs; central tendency; variation; probability; binomial, normal, t, and chi-square distributions; confidence intervals; hypothesis testing; correlation; regression; and ANOVA. *Meets the General Education Requirement: Quantitative Literacy (Math).*

Prerequisite: MATH 90 or an appropriate score on the APU mathematics placement assessment.

PHYC 112, Science and Technology for Everyday Applications, 4 Units

This course is a nonmathematical introduction to everyday science and technologies that have drastically changed the world and impacted modern life. Despite their apparent complexity, these technologies can be understood from basic physical principles. Students in this course also examine topics of current interest such as climate change, environmental stewardship, and scientific methods. This course does not carry credit toward a science major or minor. *Meets the General Education Requirement: Natural Science, Civic Knowledge and Engagement.*

Special Fee Applies

PHYC 115, Physical Science for Teachers, 3 Units

This course focuses on three fundamental concepts of physics: conservation of energy, Newton's laws, and waves. Students will engage in practices of science such as performing experiments, collecting and analyzing data, developing models, and writing and evaluating explanations. Students will also examine the nature of science and learning. Course content is aligned with content, practices, and cross-cutting concepts of the Next Generation Science Standards. This course is intended for Liberal Studies majors and does not meet the APU General Education requirement in Natural Science.

PHYC 125, Earth Science Concepts and Applications, 3 Units

This course surveys Earth both inside and out. Topics investigated include Earth's solid surface and interior, the oceans, and Earth's atmosphere and weather patterns. Emphasis is placed on dynamic processes, including human activity that affects the nature of Earth's surface. Students also explore Earth's place in the solar system, the Sun, the stars, and exotic bodies beyond the solar system. Does not meet the APU General Education requirement in Nature.

PHYC 130, Earth Science, 4 Units

Students in this course survey the physical characteristics of the Earth and the forces acting upon it. Course material includes consideration of the Earth's place in space, the nature of its crust and interior, the processes that affect its structure, and humanity's role in the processes. Lecture, 3 hours; lab, 3 hours. *Meets the General Education Requirement: Natural Science.*

Special Fee Applies

PHYC 140, Introduction to Astronomy, 4 Units

Students survey astronomical structures such as the solar system, stars, galaxies, and the entire universe, including how these structures form and change over their life spans. Course material emphasizes historical understanding of astronomy and how astronomical knowledge is discovered and interpreted using scientific methods. Lecture, 3 hours; lab, 3 hours. *Meets the General Education Requirement: Natural Science.*

Special Fee Applies

PHYC 151, Physics for Life Sciences I, 4 Units

This noncalculus physics course develops the topics of translational and rotational mechanics and provides an introduction to thermodynamics. Lecture, 3 hours; lab, 3 hours. *Meets the General Education Requirement: Natural Science.*

Special Fee Applies

Prerequisite: MATH 110 or an equivalent score on the APU mathematics placement assessment. High school geometry and trigonometry are highly recommended.

PHYC 152, Physics for Life Sciences II, 4 Units

Lecture, 3 hours; Lab, 3 hours: This noncalculus physics course develops the topics of waves, sound, light, electricity and magnetism, quantum theory, and structure of matter.

Special Fee Applies

Prerequisite: PHYC 151

PHYC 161, Physics for Science and Engineering I, 5 Units

Students in this course are introduced to various areas of physics using basic differential and integral calculus. Topics include kinematics, Newton's laws, conservation of energy, conservation of momentum, and rotation. Lecture, 4 hours; lab, 3 hours. *Meets the General Education Requirement: Natural Science.*

Special Fee Applies

Corequisite: MATH 165 or equivalent calculus background; high school physics or university-level conceptual physics strongly recommended.

PHYC 162, Physics for Science and Engineering II, 5 Units

Students in this course are introduced to various areas of physics using basic differential and integral calculus. Topics include oscillations, electricity, and magnetism. Lecture, 4 hours; lab, 3 hours.

Special Fee Applies

Prerequisite: PHYC 161 and MATH 166 (may be taken concurrently)

PHYC 263, Physics for Science and Engineering III, 5 Units

Students in this course are introduced to various aspects of physics using basic differential and integral calculus. Topics covered include thermodynamics, special relativity, vibrations and waves, optics, and nuclear and modern physics. Lecture, 4 hours; lab, 3 hours.

Special Fee Applies

Prerequisite: PHYC 161

PHYC 300, Physics Research Seminar, 1 Unit

This course surveys the major fields of modern physics research in a seminar format, with special attention to how physicists identify research questions and plan for research. The course culminates in a research proposal for the student's thesis. *Meets the General Education Requirement: Integrative and Applied Learning.*

Prerequisite: PHYC 263

PHYC 311, Teaching and Learning in STEM, 2 Units

Students in this course learn about the fundamentals of effective STEM teaching, including common challenges for STEM learners, active engagement strategies, assessment techniques, supporting diverse learners, designing assignments, and planning courses and lessons.

Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 151, PHYC 161, or equivalent

PHYC 312, STEM Education Research Seminar, 1 Unit

Students identify challenges for effective STEM education that they observe during their experiences as STEM students and in STEM teaching support roles. Using readings drawn from the STEM education research literature, students identify and evaluate solutions to these challenges.

Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 151, PHYC 161, or instructor permission

PHYC 313, STEM Teaching Practicum, 1 Unit

This course is intended for students serving in teaching support roles for STEM courses, including Learning Assistants, Teaching Assistants, and tutors. Students observe and reflect on effective STEM teaching practices and assist learners in engaging with and understanding course content.

Prerequisite: BIOL 151, CHEM 151, CS 120, MATH 165, PHYC 151, PHYC 161, or instructor permission

PHYC 361, Electricity and Magnetism, 3 Units

Students in this course study the fundamental concepts of electricity and magnetism, electrostatic fields in a vacuum and dielectric materials, solutions of the Laplace and Poisson equations, and electromagnetic waves.

Prerequisite: PHYC 162, MATH 268, and MATH 269

PHYC 370, Waves and Optics, 3 Units

Students in this course study mechanical and electromagnetic waves and explore topics such as geometric optics, wave propagation, interference, diffraction, polarization, coherence, and holography, as well as topics from nonlinear optics.

Prerequisite: PHYC 263, MATH 268, and MATH 270 (may be taken concurrently).

PHYC 380, Classical Mechanics, 4 Units

Students in this course apply mathematical methods commonly used in physics modeling and analysis to the study of particles experiencing linear and quadratic drag, momentum, energy, driven oscillations, central force motion, rigid-body rotation, and Lagrangian dynamics. The mathematical methods used include infinite series, complex numbers, linear algebra, curvilinear coordinates, vector calculus, Fourier analysis, partial differential equations, variational calculus, and numerical methods.

Prerequisite: PHYC 161, MATH 167, MATH 268, MATH 269, and MATH 270

PHYC 401, Thermodynamics, 3 Units

Students in this course learn the theoretical basis of classical thermodynamics and statistical mechanics including the zeroth, first, second, and third laws. These laws are applied to equilibrium systems such as ideal gases, heat engines, chemical reactions, and phase transitions.

Prerequisite: PHYC 263 and MATH 268 (may be taken concurrently)

PHYC 431, Computational Methods for Physics, 3 Units

Students in this course develop numerical modeling skills to solve representative problems in mechanics, quantum mechanics, thermal physics, and electromagnetism. The problems solved include multibody dynamics under gravity, Laplace's equation, the wave equation, the Ising model, the time-independent Schrodinger equation, and molecular dynamics.
Prerequisite: CS 120, MATH 268, MATH 270

PHYC 440, Quantum Mechanics, 3 Units

Students are introduced to the time-dependent and time-independent Schrodinger equations. The Schrodinger equation is solved for examples including potential wells and barriers, harmonic oscillators, and hydrogen atoms. These examples illustrate the concepts of quantization of energy and angular momentum, tunneling, wave properties of particles, and the uncertainty principle.
Prerequisite: MATH 270 and PHYC 370, or instructor consent

PHYC 470, Writing 3: Advanced Laboratory, 3 Units

This course prepares students for writing scientific journal articles and presenting scientific results to a technical audience. This course also acquaints students with advanced laboratory and analysis techniques. Activities include instruction and practice in scientific writing and presenting scientific information orally. *Meets the General Education Requirement: Writing 3: Writing in the Disciplines.*
Special Fee Applies
Prerequisite: PHYC 263, Writing 2, and junior or senior standing or instructor's consent.

PHYC 497, Readings, 1-4 Units

This is a program of study concentrating on assigned readings, discussions, and writing arranged between and designed by a student of upper-division standing and a full-time professor. An independent study fee is assessed for each enrollment in this class.

PHYC 498, Directed Research, 1-4 Units

This course provides instruction in research design and technique, and gives students experience in the research process. The 1-unit expectation encompasses no fewer than 30 hours of work with accompanying reading, log, writing, and seminar presentation within the department or in a university research symposium. No more than 1 unit may be used to fulfill preparatory readings requirement. An independent study fee is assessed for each enrollment in this class.
Prerequisite: Junior or Senior Standing

PHYC 499, Physics Thesis, 1-4 Units

Students engage in original research projects in collaboration with a faculty member. Projects may be experimental, theoretical, or computational in nature, and projects expand upon learning from previous courses in the major and apply that learning to make a novel contribution to the field. Successful completion of the course results in completion of a journal-style article and/or professional-level poster presentation. *Meets the General Education Requirement: Integrative and Applied Learning.*
Prerequisite: PHYC 300

PRPY 110, Principles of Physical Science, 3 Units

Basic concepts in physics, chemistry, and the solar system are investigated. Emphasis is placed on basic principles and their applications to modern technology and everyday experiences. Some problems requiring simple math are discussed and solved, but detailed mathematical derivations are more appropriate in other courses. Part of this course is also committed to reviewing historical developments of scientific thought, examining the perceived conflict between science and Christianity, and analyzing evidence for a Creator from scientific discoveries. This course does not carry credit toward a science major or minor. *Meets the General Education Requirement: Natural Science (PHYC 110 + PHYC 111).*

PRPY 112, Science and Technology for Everyday Applications, 4 Units

This course is a nonmathematical introduction to everyday science and technologies that have drastically changed the world and impacted modern life. Despite their apparent complexity, these technologies can be understood from basic physical principles. Students in this course also examine topics of current interest such as climate change, environmental stewardship, and scientific methods. This course does not carry credit toward a science major or minor. *Meets the General Education Requirement: Natural Science, Civic Knowledge and Engagement.*
Special Fee Applies

PRPY 125, Earth Science Concepts and Applications, 3 Units

This course surveys Earth both inside and out. Topics investigated include Earth's solid surface and interior, the oceans, and Earth's atmosphere and weather patterns. Emphasis is placed on dynamic processes, including human activity that affects the nature of Earth's surface. Students also explore Earth's place in the solar system, the Sun, the stars, and exotic bodies beyond the solar system. Does not meet the APU General Education requirement in Nature.

PRPY 140, Introduction to Astronomy, 4 Units

This course introduces the history of astronomy, the solar system, the stellar systems, galactic systems, and cosmology. A lab is included. Lecture, 3 hours; lab, 3 hours. *Meets the General Education Requirement: Natural Science.*
Special Fee Applies

STAT 501, Introduction to Modeling with Probability, 3 Units

This course is an introduction to probability models used in statistics and data analysis. Topics include basic axioms of probability, random variables, probability distributions, expected values, and probability distribution theory.

Prerequisite: Calculus (multivariable preferred) and linear algebra; students who are lacking in one area or the other may satisfy the prerequisite by passing MATH 199 and/or MATH 299.

STAT 502, Mathematical Statistics, 3 Units

This course offers an introduction to descriptive and inferential statistics used in data analysis. Topics include random sampling, parameter estimation, hypothesis testing and goodness of fit, summarizing data, and comparing samples.

Prerequisite: STAT 501

STAT 511, Applied Regression Analysis, 3 Units

This course is an introduction to simple and multiple linear regression models. Topics include parameter estimation, diagnostics, model selection, prediction, and models with categorical predictors.

Prerequisite: STAT 501;

Corequisite: STAT 502

STAT 512, Analysis of Variance and Design of Experiments, 3 Units

This course offers an introduction to designing and analyzing data using experiments. Basic experimental designs are covered, including block, factorial, and fractional factorial. Analysis of Variance (ANOVA) models and their assumptions, estimation, and interpretation are introduced. Statistical software is used for all analysis.

Prerequisite: STAT 501;

Corequisites: STAT 502, STAT 511

STAT 521, Statistical Computing and Programming, 3 Units

Students in this course gain basic familiarity with SAS and R programming for data management and analysis. The course takes place in a computer lab, enabling students to implement the lecture material as it is presented. Assignments require using SAS and R to perform data management techniques, generate descriptive statistics and graphical representations of data, and apply statistical methods available in software.

Prerequisite: MATH 361 or equivalent

STAT 541, Epidemiology Research Methods, 3 Units

The purpose of this course is to equip students with the basic concepts and principles of epidemiology, a discipline that identifies the determinants of disease in human populations and assesses the magnitude of public health problems and the success of interventions designed to control them. Students learn about various epidemiologic study designs and their strengths and limitations, the basic mathematical tools needed in epidemiology, the collection of epidemiologic data, and the criteria of causality. Also, the course addresses the biases that may invalidate epidemiologic studies, and considers ethical concerns in epidemiology from a Christian faith perspective.

STAT 542, Applied Logistic Regression and Survival Analysis, 3 Units

This course offers an introduction to methods for analyzing binary outcome and time-to-event data, with the primary focus on how to analyze such data using methods available in standard statistical software packages. Topics include logistic regression estimation, interpretation, and assessment. For time-to-event data, summary statistics for censored data, nonparametric methods (specifically Kaplan-Meier), and semiparametric regression methods centered on the Cox model are introduced.

Prerequisite: STAT 511 and STAT 521 or equivalent

STAT 543, Applied Longitudinal Data Analysis, 3 Units

This course focuses on classical and modern approaches to analyzing continuous and discrete longitudinal data. Topics include exploratory analysis of correlated data, random effects models, Generalized Estimating Equations (GEE), and analysis of discrete longitudinal data. Emphasis is on estimation using statistical software and model interpretation.

Prerequisite: STAT 511 and STAT 521 or equivalent

STAT 551, Data Visualization, 3 Units

This course introduces students to the field of data visualization. Students learn basic visualization design and evaluation principles, and also how to acquire, parse, and analyze data sets using various data visualization software tools. Data types included in the course include multivariate, temporal, text-based, geospatial, and network/graph-based.

Prerequisite: B- or better in MATH 295 and MATH 361, or admission to graduate school.

STAT 552, Time Series Analysis and Forecasting, 3 Units

In this course, students develop a working knowledge of time series analysis and forecasting methods, with a focus on applications. Topics include descriptive analysis, probability models for time series, fitting and forecasting for time series models, bootstrapping, models for nonstationary series, and an introduction to spectral analysis.

Prerequisite: STAT 502 and STAT 521

STAT 553, Data Mining, 3 Units

Data mining focuses on algorithms and computational paradigms that allow computers to find patterns and regularities in data in order to perform prediction or find structure and relationships to help improve decision making. This course covers basic methodology, major software tools, and applications in data mining. Students learn conceptual underpinnings of methods in data mining while focusing more on usage of existing software packages than developing the algorithms. In particular, the course covers the methodology, motivation, assumptions, strengths, and weaknesses of the most widely applicable methods in the field.
Prerequisite: STAT 511 or STAT 521 or STAT 551 or PSYC 518

STAT 571, Applied Multivariate Analysis, 3 Units

This course introduces a variety of standard statistical methods used to analyze multivariate data, emphasizing the implementation and interpretations of the methods. Topics covered include matrix computation of summary statistics, graphical techniques, the geometry of sample data, the multivariate normal distribution, principal components analysis, factor analysis, classification and discrimination, and cluster analysis.
Prerequisite: STAT 511 and STAT 521

STAT 572, Applied Bayesian Analysis, 3 Units

This course provides a practical introduction to Bayesian data analysis. Students are exposed to a variety of Bayesian models, including the Bayesian linear model and Bayesian hierarchical modeling as a strategy for modeling complex processes and as a means of assimilating a variety of sources of data. Models are fit for various types of data using modern simulation techniques in statistical software. The focus of the course is modeling, assessing model appropriateness, and interpretation.
Prerequisite: STAT 511 and STAT 521

STAT 573, Applied Nonparametric Statistics, 3 Units

This course provides an overview of nonparametric statistics, helping students learn the difference between parametric and nonparametric statistics and when each is appropriate. This course includes the basic theory and computing tools to perform traditional rank-based nonparametric tests, and advanced topics include nonparametric density estimation, nonparametric regression, and the bootstrap.
Prerequisite: STAT 511 and STAT 521

STAT 574, Discrete Data Analysis, 3 Units

This course covers basic methods for analysis of discrete data, including methods for analyzing and describing discrete data in contingency tables, and statistical models for discrete outcomes that are binary, counts, nominal, and ordinal. Emphasis is on using statistical software to fit models to data, assessing the appropriateness, and interpreting the results in context.
Prerequisite: STAT 511 and STAT 521

STAT 575, Applied Survey Sampling, 3 Units

This course covers sampling design and analysis methods useful for research and management in many fields. Students learn about the basic methods of sampling and estimation and then explore selected designs and recent developments. Topics include simple random sampling with associated estimation and confidence interval methods, selecting sample sizes, estimating proportions, unequal probability sampling, ratio and regression estimation, stratified sampling, cluster, systematic sampling, multistage designs, and double sampling.
Prerequisite: STAT 502 and STAT 521

STAT 592, Ethics in Data Analytics, 2 Units

The availability and use of data has led to tremendous opportunities. Businesses mine data to gain a competitive advantage, and healthcare organizations use it to help improve medical decision making. The use of data, however, has led to potential abuses. This course explores ethical issues in big data analytics, including issues surrounding collection, use, and reporting of data, and considers them from a Christian worldview.

STAT 595, Special Topics in Applied Statistics, 3 Units

This course presents coverage of topics in applied statistics.
Prerequisite: Based upon the topic offered.

STAT 596, Practicum, 0-1 Units

In this course - the practicum course of the Master of Science in Applied Statistics and Analytics program - students collaborate with professionals in academic or industry organizations to develop professional experience.
Prerequisite: Instructor permission required

STAT 597, Statistical Consulting Practicum, 4 Units

Students in this course investigate the role of the statistician as consultant and collaborator. Topics include problem solving and communication skills (oral and written), structuring working engagements with nonstatisticians and collaborators, and skills specific to statistical consulting. Case studies or ongoing projects are used to provide hands-on consulting experience. Students identify, and produce their proposal for, their culminating project during this course.
Prerequisite: STAT 511 and STAT 521

STAT 598, Culminating Project, 4 Units

This is the capstone course of the Master of Science in Applied Statistics and Analytics program. It is open to second-year students in good standing. Students provide an oral presentation and a written report of the project.
Prerequisite: STAT 597

STAT 599, Independent Study, 1-3 Units

Faculty

Chair

Bradley McCoy (http://www.apu.edu/faculty/bmccoy/), PhD, Physics

Program Director, MS in Applied Statistics and Data Science

Soeun Kim (http://www.apu.edu/faculty/soeunkim/), PhD, Statistics

Professors

Mark Arvidson (http://www.apu.edu/faculty/marvidson/), PhD, Mathematics

Enson Chang (http://www.apu.edu/faculty/echang/), PhD, Physics

Bryant Mathews (http://www.apu.edu/faculty/bmathews/), PhD, Mathematics

Bradley McCoy (http://www.apu.edu/faculty/bmccoy/), PhD, Physics

Associate Professors

Edwin Ding (http://www.apu.edu/faculty/eding/), PhD, Mathematics

Soeun Kim (http://www.apu.edu/faculty/soeunkim/), PhD, Statistics

Sharon McCathern (http://www.apu.edu/faculty/smccathern/), PhD, Mathematics

Sándor Volkán-Kacsó (http://www.apu.edu/faculty/skacso/), PhD, Physics

Assistant Professor

Kaitlyn Fitzgerald (http://www.apu.edu/faculty/kfitzgerald/), PhD, Mathematics

Adjunct Faculty

Brian Croissant, MS

Daniel Hogue (http://www.apu.edu/clas/faculty/dhogue/), MS

Derek Morrison, MA

Steven Moser, MS

Danielle Nazaroff, MA

Amanda Sinner, MA

Molly Swanson, MA

Alyssa Thornton, BS

Jeffrey Zweerink, PhD