



Faculty

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Degrees and Programs

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The *Mathematics and Physics Department* provides courses for future data scientists, mathematicians, and physicists, for teacher education, pre-medicine, general education, and programs in other departments. A common goal of each course is that students will develop problem-solving skills based on mathematical reasoning and understanding, not merely rote memorization. The biophysics curriculum focuses on applications of the fundamental laws of nature to applications in biology. These courses involve learning about physical and mathematical modes developed through observation and experimentation that help us understand and explain the physical universe. Although modern science limits itself to the naturalistic view of reality and to experimental ways of obtaining knowledge, the Mathematics and Physics Department takes the view that physical phenomena are consistent with the concept of a divine Creator.

Students majoring in mathematics will have experience with mathematical modeling, abstraction, generalization, logical analysis, and mathematical technology. Students may select courses in order to focus on pure mathematics, applied math-

ematics, mathematics education, or actuarial certification. The major advisor will assist students with the selection of appropriate courses for each area of focus.

The biomathematics major is an attractive way to prepare for medical or dental school. The major provides excellent preparation for graduate study leading to a Master's Degree in Public Health with emphasis in statistical analysis. A growing area of biological research uses sophisticated mathematics to study genetics, population fluctuations, and metabolic functions. This major provides entry to such graduate programs as biomathematics, biostatistics, mathematical biology, and biometrics.

The biophysics program provides a curriculum in the physical sciences demanded for graduate study in biophysics, physiology, medicine, medical research, radiation biology, and molecular biology. This program is also recommended as a broad major for teaching at the secondary-school level.

Data science is a fast-evolving interdisciplinary field centered on obtaining, organizing, and analyzing data. The data science major includes courses in data science, mathematics, statistics, and business to prepare students for employment in a variety of industries, including entertainment, healthcare, technology, and political and social sciences. The degree also provides a background for graduate study in data science or related fields.

Undergraduate Research Opportunities:

Since 2008, PUC students have participated in world-class physics research, most of which has been funded through grants from the National Science Foundation and NASA. As a result, students have traveled to many national laboratories and international conferences; some have published the results of their research in peer-reviewed journals.

Small Class Sizes:

Small class sizes promote communication and teamwork opportunities among students and faculty.

Mathematics and Physics

Major in Mathematics, B.S.

A minimum of 68 hours (at least 29.5 upper-division hours)

► Required Core Courses (46 hours):

MATH 131+132	Calculus I, II	4+4
MATH 265	Elementary Linear Algebra	4
MATH 267	Multivariable Calculus	5
MATH 269	Elementary Differential Equations	4
MATH 275	Logic and Sets	4
MATH 290	Sophomore Seminar	0.5
MATH 331	Theory of Probability & Statistics	4
MATH 351	Introduction to Abstract Algebra I	4
MATH 385	Mathematical Modeling	4
MATH 421	Elementary Real Analysis I	4
MATH 390+490	Junior + Senior Seminar	0.5+1

At least one of the following courses: 3

MATH 352 Introduction to Abstract Algebra II (3)

MATH 422 Elementary Real Analysis II (3)

► Required Core Electives (15 hours):

At least 15 hours of additional MATH courses, 15
of which at least 9 hours must be upper-division.

► Required Cognate Courses (7-9 hours):

INFS 115 Intro to Computer Programming 4

At least one of the following courses: 3-5

CHEM 451 Physical Chemistry (3)

FIN 341 Finance (5)

INFS 470 Business Analytics (3)

PHYS 265 Calculus Applications for Physics (3)

STAT 322 Statistical Methods (3)

All core and cognate courses should be chosen in consultation with the major advisor. In selecting courses, students are encouraged to consider the recommendations below:

Recommended Courses

Pure Mathematics

A focus on pure mathematics can lead to careers in university teaching and research following graduate studies in mathematics and related areas, such as statistics, computer science, and physics. Recommended courses: MATH 267, MATH 352, MATH 422, MATH 425, and MATH 465.

Applied Mathematics

A focus on applied mathematics is a path to careers in medicine, government, business, and industry following graduate study in such areas as computational biology, operations research, and applied statistics. Recommended courses: STAT 322, INFS 470, a minor or second major in an applied field such as Biology, Business Administration, or Psychology.

Mathematics Education

A focus on mathematics education is a major component in a program of studies leading to the California Teaching Credential in secondary school mathematics. Recommended courses: MATH 341, MATH 354, MATH 385, and MATH 451.

Actuarial Certification

Actuarial certification can lead to careers in the insurance and investment industry, where actuaries use a broad knowledge of statistics, finance, and business. Recommended courses for students interested in preparing for the national examinations for actuarial certification: MATH 267, STAT 322, and INFS 470.

Teaching Credential

Students desiring to enter a program of studies leading to a California teaching credential in mathematics should take the B.S. degree in Mathematics and complete the recommended courses for the Mathematics Education focus. Students will need to pass the mathematics portion of the CSET exam one quarter prior to doing full-time student teaching. Students are invited to discuss the program with their major advisor in the Mathematics Department.

Those who plan to teach on the secondary level should consult with the credential analyst in the Education Department and should become acquainted with the specific requirements for admission to and successful completion of the Teacher Education Program as outlined in the section entitled "Education" in this catalog.

Minor in Mathematics

A minimum of 27 hours (6 upper-division hours)

Take at least 27 hours (6 upper-division) chosen from any non-service MATH courses. STAT 322 may also apply to the minor.

Major in Biomathematics, B.S.

A minimum of 86 hours (29.5 upper-division hours)

► *Required Core Courses (68.5 hours):*

BIOL 112+111+113	Biological Foundations II, I, III	5+5+5
BIOL 222	Introduction to Research Methods	2
CHEM 111+111L	General Chemistry I + Lab	4+1
CHEM 112+112L	General Chemistry II + Lab	4+1
CHEM 113+113L	General Chemistry III + Lab	4+1
INFS 115	Intro to Computer Programming	4
MATH 131+132	Calculus I, II	4+4
MATH 265	Elementary Linear Algebra	4
MATH 269	Elementary Differential Equations	4
MATH 275	Logic and Sets	4
MATH 290	Sophomore Seminar	0.5
MATH 384	Biomathematics	4
MATH 385	Mathematical Modeling	4
MATH 390+490	Junior + Senior Seminar	0.5 + 1
STAT 322	Statistical Methods	3

► *Required Core Electives (17 hours):*

At least 17 hours from the following courses: 17

(Include at least one MATH course and two BIOL courses)

BIOL 320	Cell and Molecular Biology (4)
BIOL 328	Animal Behavior (4)
BIOL 331	Marine Science (4)
BIOL 338	Field Biology (3)
BIOL 348	Systems Physiology (5)
BIOL 354	Genetics (4)
BIOL 430	Neurobiology (4)
BIOL 469	Immunology (4)
CHEM 371+371L	Organic Chemistry I + Lab (3+1)
CHEM 372+372L	Organic Chemistry II + Lab (3+1)
MATH 331	Theory of Probability & Statistics (4)
MATH 351+352	Intro to Abstract Algebra I, II (4+3)
MATH 421+422	Elementary Real Analysis I, II (4+3)
MATH 425	Complex Analysis (4)
MATH 465	Linear Algebra (4)

Recommended Cognate Courses:

CHEM 373+373L	Organic Chemistry III + Lab (3+1)
CHEM 481	Biochemistry I (4)
PHYS 111+112+113	General Physics I, II, III (4+4+4)
PHYS 265	Calculus Applications for Physics (3)

Major in Biophysics, B.S.

A minimum of 106 hours (39 upper-division hours)

► *Required Core Courses (96.5 hours):*

BIOL 112+111+113	Biological Foundations II, I, III	5+5+5
BIOL 320	Cellular and Molecular Biology	4
BIOL 348	Systems Physiology	5
CHEM 111+111L	General Chemistry I + Lab	4+1
CHEM 112+112L	General Chemistry II + Lab	4+1
CHEM 113+113L	General Chemistry III + Lab	4+1
CHEM 371+371L	Organic Chemistry I + Lab	3+1
CHEM 372+372L	Organic Chemistry II+Lab	3+1
CHEM 373+373L	Organic Chemistry III + Lab	3+1
CHEM 481	Biochemistry I	4
MATH 131+132	Calculus I, II	4+4
MATH 267	Multivariable Calculus	5
PHYS 111+112+113	General Physics I, II, III	4+4+4
PHYS 265	Calculus Applications for Physics	3
PHYS 280	Introduction to Physical Science	1
PHYS 290	Sophomore Seminar	0.5
PHYS 314	Elementary Modern Physics	4
PHYS 321	Biophysics	3
PHYS 322	Medical Physics	3
PHYS 380	Research in Physics	1
PHYS 490	Senior Seminar in Physics	1

► *Required Core Electives (10 hours):*

At least 10 hours from the following courses: 17

(Include at least 2 upper-division hours)

Select additional non-service BIOL and PHYS courses.

CHEM 450L, CHEM 451, CHEM 482, and CHEM 452 may also apply.

Recommended Courses:

INFS 115	Intro to Computer Programming	4
MICR 134	General Microbiology	5

This program provides the additional emphasis in the physical sciences demanded for graduate study in biophysics, physiology, medicine, medical research, radiation biology, and molecular biology. This program is also recommended as a broad major for teaching at the secondary-school level.

Teaching Credential

Students desiring to enter a program of studies leading to a California teaching credential in science with a concentration in physics should take the B.S. degree in Biophysics. Students will need to pass the science (physics concentration) portion of the CSET exam one quarter prior to doing full-time student

Mathematics and Physics

teaching. Students are invited to discuss the program with their major advisor in the Mathematics and Physics Department.

Those who plan to teach on the secondary level should consult with the credential analyst in the Education Department and should become acquainted with the specific requirements for admission to and successful completion of the Teacher Education Program as outlined in the section entitled “Education” in this catalog

Minor in Physics

A minimum of 27 hours (12 upper-division hours)

Take 27 hours (12 upper-division) chosen from any non-service PHYS courses.

Major in Data Science, B.S

A minimum of 80.5 hours (37 upper-division hours)

► Required Core Courses (68.5 hours):

DTSC 101	Intro to Data Science	4
DTSC 201	Fundamentals of Data Science	4
DTSC 215	Frmwrks & Libs for Data Science	4
DTSC 290	Sophomore Seminar	0.5
DTSC 323L	Statistical Methods in Data Sci Lab	1
DTSC 420	Machine Learning	3
DTSC 425	Legal and Ethical Aspects of Data	2
DTSC 490	Senior Seminar	1
DTSC 494	Internship	1
INFS 115	Intro to Computer Programming	4
INFS 240	Introduction to GIS	2
INFS 320	Business Intelligence	3
INFS 380	Database Analysis and Design	3
MATH 131+132	Calculus I, II	4+4
MATH 265	Elementary Linear Algebra	4
MATH 267	Multivariable Calculus	5
MATH 269	Elementary Differential Equations	4
MATH 275	Logic and Sets	4
MATH 331	Theory of Probability and Statistics	3
MATH 385	Mathematical Modeling	4
STAT 322	Statistical Methods	3

► Required Core Electives (12 hours):

At least 12 hours from the following:

Upper-division MATH courses.

Upper-division INFS courses.

Repeat DTSC 494 for additional credit.

Many of the core and elective courses for this major carry pre-requisites. All courses should be chosen and sequenced in consultation with the major advisor.

Astronomy

LOWER-DIVISION COURSE:

ASTR 115

5 F, W

Astronomy

An introduction for the general student to the basic elements of astronomy. Topics include models of the solar system, stars and their processes, clusters, galaxies, cosmology, and relevant physics topics such as light, spectroscopy, nuclear reactions, and relativity. Emphasizes the development of scientific ideas and models for the structure and contents of the universe and the effects of those ideas on western civilization. Laboratory activities emphasize personal observations of various astronomical objects, as weather permits. Four lectures and one evening laboratory per week. Prerequisite: MATH 094 or MATH 096 or equivalent.

Data Science

LOWER-DIVISION COURSES:

DTSC 101

4 F

Introduction to Data Science

A hands-on, exploratory introduction to data and problem solving with data. An overview of various data types and elementary techniques for uncovering relationships among data. Programming software is used to manipulate data, visualize data, and develop simple scripts to answer a variety of questions related to read data sets.

DTSC 201

4 S

Fundamentals of Data Science

A follow up to the introductory course DTSC 101 with an emphasis on data collection, data cleaning, estimation, prediction, and inference. Programming software is used to write more involved functions and scripts for deeper analysis of real data sets. Prerequisite: DTSC 101.

DTSC 215 **4 F**
Frameworks and Libraries for Data Scientists

An overview of a variety of frameworks and libraries for Python used in data science. Emphasizes tools for data processing and modeling, data visualization, and data mining and understanding their accompanying documentation. Frameworks may include Jupyter Notebooks, Pandas, or SciKit. Libraries may include NumPy, Matplotlib, or Scrapy. Prerequisite: INFS 115.

DTSC 290 **0.5 W**
Sophomore Seminar

Preparation for students for successful pursuit of opportunities in mathematics-related fields of work and study. Includes an introduction to tools and resources used in mathematical work, CV/resume writing, major portfolio preparation, and identifying/pursuing internships and research experiences for undergraduates (REUs). Prerequisite: DTSC 101. Graded S/F.

UPPER-DIVISION COURSES:

DTSC 323L **1 W**
Statistical Methods in Data Science Lab

A lab course applying statistical methods that may include multiple and logistic regression, analysis of variance, decision trees, splines, and LASSO using programming software (e.g., R., Python). Prerequisite: DTSC 201. Corequisite: STAT 322.

DTSC 420 **3 W**
Machine Learning

An introduction to the theory and algorithms pertaining to classification, regression, and clustering. Topics include perceptrons, support vector machines, linear regression, logistic regression, ridge regression, kernels, mixed Gaussians, neural networks, the nearest neighbor algorithm, principal component analysis, and k-means clustering. Programming software is used to implement selected algorithms and apply them to real data sets. Prerequisites: DTSC 215, DTSC 323L. Even Years.

DTSC 425 **2 F**
Legal and Ethical Aspects of Data

This course provides an introduction to critical ethical issues surrounding data and society. It blends social and historical perspectives on data with ethics, policy, and case examples to help students develop a workable understanding of current ethical issues in data science. Ethical and policy-related concepts addressed include: challenges inherent in data analytics and privacy, data and discrimination, ethical frameworks for organizational use of data, and the ethical ramifications of the use of artificial intelligence in data science. Odd years.

DTSC 490 **1 S**
Senior Seminar

Topics of current interest in data science. Under supervision of departmental faculty, each student will prepare and present a paper on a topic of interest. Prerequisite: DTSC 420, DTSC 425.

DTSC 494 **1 F,W,S**
Internship

(See BUAD 494.)
 SERVICE COURSES:
(Not applicable to a major or minor in this department)

Mathematics

MATH 093+094 **4 W,S**
Algebra with Financial Applications I & II

Concepts and techniques of algebra in a financial context for students without recent experience in algebra and not pursuing studies in the sciences. MATH 093 includes algebraic expressions, basic descriptive statistics, modeling with polynomial and exponential equations and regression, arithmetic and geometric sequences, exponentials and logarithms, systems of linear equations, and spreadsheets. Financial topics may include discretionary expenses, checking and investments, consumer credit, automobile ownership, employment basics, and income taxes.

MATH 094 includes graphing and solving systems of linear equations, graphing and solving quadratic equations, complex numbers, basic probability and expected value, modeling with polynomial regression, matrices, and spreadsheets. Financial topics may include home rental and ownership, stock market, business modeling, retirement, and budgeting. Prerequisite: MATH 093.

MATH 095+096 **4+4 F, W, S**
Basic Algebra I, II

Basic concepts and techniques of algebra for students without recent experience in algebra.

MATH 095 includes integers, algebraic expressions, first degree equations and inequalities, simple rational expressions and proportions, integer exponents, scientific notation, functions, graphs, and solutions of linear equations and systems.

MATH 096 includes factoring, functions, rational and radical expressions, integer exponents and square roots, complex numbers, and solutions of quadratic and rational equations. Prerequisite: MATH 095.

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MATH 100 **1-2 F,W,S** **Supplemental Topics in College Algebra (WEB):**

A review of intermediate algebra, including exponents and radicals, linear, quadratic and rational equations, and inequalities. The number of credits is determined by initial assessment. Prerequisite: MATH 094 or 096 or equivalent. Graded S/F.

MATH 106 **3 F, S** **College Algebra**

Study of functions including polynomial and rational functions, binomial theorem, composition and inverse of functions, exponentials and logarithms, systems of equations, arithmetic and geometric progressions. Other topics may include further study of polynomials and/or linear programming. Prerequisite: MATH 100 (prior or concurrent).

MATH 113 **2 F** **Trigonometry**

A study of the six trigonometric functions and their relationships to one another, as well as the study of applications involving these six functions. Included are degree and radian measure, right triangle trigonometry, graphs of the trigonometric functions, inverse trigonometric functions, fundamental identities, addition identities, double-angle and half-angle identities, solutions of trigonometric equations, law of cosines, law of sines, and vector triangles. Prerequisite: Prerequisite: MATH 100 (prior or concurrent)..

MATH 211+212 **3+3 F+W** **Foundations of School Mathematics I, II**

A two-quarter sequence covering the logic and structure underlying school mathematics. Concepts, procedures, problem-solving and applications at concrete, pictorial, and abstract levels.

Must be taken in sequence. Prerequisite: MATH 094 or 096 or equivalent.

MATH 211 includes problem-solving techniques, sets, logic and deductive reasoning, the arithmetic of whole numbers, fractions, decimals, integers, rational and real numbers, ratio and proportion, and percent.

MATH 212 includes geometry, measurement, and basic probability.

LOWER-DIVISION COURSES:

MATH 131+132 **4+4 FW, WS** **Calculus I, II**

A two-quarter standard sequence in single-variable calculus. Must be taken in sequence. Prerequisite: Knowledge of algebra and trigonometry at the level provided by MATH 106 and 113.

MATH 131 focuses on differential calculus and its applications. Includes limits, all derivative tools (including transcendental functions), maximizing/minimizing applications, related rates, L'Hospital's rule, and antiderivatives. Graphing calculators and mathematical software tools are used extensively. Offered F, W.

MATH 132 focuses on integral calculus and its applications. Includes the fundamental theorems, general substitutions, integration by parts, applications to geometry and physics, differential equations, growth models, infinite series, and Taylor expansions. Graphing calculators and mathematical software tools are used extensively. Offered W, S.

MATH 265 **4 S** **Elementary Linear Algebra**

Matrix algebra and determinants, applications to solving systems of linear equations, vector spaces, linear transformations, eigenvalues, and eigenvectors. Prerequisite: MATH 131.

MATH 267 **5 F** **Multivariable Calculus**

Vector functions and functions of more than one variable, solid analytic geometry, parametric curves and surfaces, partial derivatives, gradients, multiple integrals, line and surface integrals, divergence, curl, and Stokes' Theorem. Prerequisite: MATH 132. Recommended prerequisite: MATH 265

MATH 269 **4 W** **Elementary Differential Equations**

Ordinary differential equations balancing analytic techniques, qualitative methods, and basic modeling. Topics include eigenvalue methods for linear systems, Laplace transforms, phase plane, null-clines, equilibria, harmonic oscillator, and population models. Prerequisite: MATH 132. Recommended prerequisite: MATH 265.

MATH 275 **4 S** **Logic and Sets**

A bridge to upper-division mathematics, developing the student's ability to handle abstract concepts and careful proofs. Propositional and predicate logic, various types of proof, algebra of sets and functions, equivalence relations, and countable sets. Prerequisite: MATH 131.

MATH 290 **0.5 W** **Sophomore Seminar**

Preparation of students for successful pursuit of opportunities in mathematics related fields of work and study. Includes an introduction to tools and resources used in mathematical work, CV/résumé writing, major portfolio preparation, and identifying/pursuing internships and research experiences for undergraduates (REUs). Graded S/F.

UPPER-DIVISION COURSES:

MATH 331 **4 F** **Theory of Probability and Statistics**

Theory and applications of probability models, combinatoric problems, random variables, discrete and continuous distributions, expectation, moment generating functions, and central limit theorem. Prerequisites: MATH 132, STAT 222. Odd years.

MATH 341 **4 W** **Geometries**

The development and history of Euclidean geometry, the axiomatic method and various axiom sets for Euclidean geometry, history of the parallel postulate and discovery of non-Euclidean geometry, neutral and hyperbolic geometry, philosophical implications. Prerequisite: MATH 275. Even years.

MATH 351+352 **4+3 F+W** **Introduction to Abstract Algebra I, II**

A two-quarter sequence introducing the basic topics in modern abstract algebra. Must be taken in sequence. Prerequisite: MATH 275. Odd years.

MATH 351 is a basic introduction to groups, rings, integral domains, fields, and isomorphisms. Also included are mappings, equivalence relations, and modular arithmetic.

MATH 352 is a continuation that stresses applications. Topics studied may include polynomials, elementary Galois theory, geometric constructions, algebraic coding, lattices, and Boolean algebras.

MATH 354 **3 F** **Number Theory**

Topics include Diophantine equations, theorems and conjectures about prime numbers, congruences, the theorems of Euler and Fermat, perfect numbers, continued fractions, and Pythagorean triples. Prerequisite: MATH 275. Even years.

MATH 384 **4 S** **Biomathematics**

An introduction to the applications of mathematical methods in the modeling of various biological phenomena. Connections are made between diverse biological examples linked by common mathematical themes. Explorations may be selected from a variety of discrete and continuous ordinary or partial differential equation models. Prerequisites: MATH 269, 275. Recommended prerequisites: MATH 265 and INFS 115. Odd years.

MATH 385 **4 S** **Mathematical Modeling**

Mathematical modeling of problems selected from a variety of applied areas, including industry, biology, business, and the social sciences. Both deterministic and stochastic models are considered, with an emphasis on practical problem-solving. Includes exploration of the computer as a problem-solving tool. Prerequisites: MATH 269, 275. Recommended prerequisites: MATH 265 and INFS 115. Even years.

MATH 390 **0.5 S** **Junior Seminar**

Continued preparation of students for successful pursuit of opportunities in mathematics related fields of work and study. Includes mathematics problem solving in a variety of topics and contexts, investigating employment and further education opportunities for (bio) mathematics graduates, CV and résumé updating, continued major portfolio preparation, introduction to professional mathematics organizations/publications/PUC library resources, and identifying topics of interest for further study in senior seminar. Prerequisite: MATH 290. Graded S/F.

MATH 421+422 **4+3 F+W** **Elementary Real Analysis I, II**

A two-quarter sequence focusing on the fundamental definitions and theorems underlying single-variable calculus and related topics. Must be taken in sequence. Prerequisites: MATH 132, 275. Even years.

MATH 421 includes the completeness property, limits of sequences and functions, and continuity.

MATH 422 is a continuation that covers derivatives, the Riemann integral, and infinite series.

MATH 425 **4 S** **Complex Analysis**

The elements of the theory of analytic functions including Cauchy's theorem, calculus of residues, conformality, and applications. Prerequisites: MATH 267, 275. Even years.

MATH 451 **4 W** **History of Mathematics**

A survey of major developments in mathematics from antiquity to modern times. Involves historically relevant problem sets, class discussions, and presentations by students and teacher. Prerequisite: MATH 131. Odd years.

MATH 465 **4 S** **Linear Algebra**

A deeper study than given in MATH 265, including Jordan form, inner product spaces, quadratic forms, Hamilton-Cayley theorem, and normal operators. Prerequisites: MATH 265, 351. Odd years.

MATH 485 **1-4 Arranged** **Special Topics in Mathematics**

Study of a selected topic not covered elsewhere in the curriculum. Course content varies from year to year, with topics

Mathematics and Physics

such as Topology, Differential Geometry, Chaos & Fractals, and Formal Logic & Gödel's Theorems. Repeatable for credit under different subtitles.

MATH 490 **1 S** **Senior Seminar**

Continued preparation of students for successful pursuit of opportunities in mathematics related fields of work and study. Includes mathematics problem solving in a variety of topics and contexts, continued major portfolio preparation, and an in-depth study of a topic of interest in a field related to mathematics. Prerequisite: MATH 390.

MATH 495 **1-3 Arranged** **Independent Study**

Qualified students may, with the approval of the department chair, undertake a directed research problem suited to their background and experience. Repeatable to a maximum of 9 credits.

Physics

SERVICE COURSES:

(Not applicable to a major or minor in this department)

PHYS 105 **5 S** **Introduction to Physics**

Emphasizes the ideas and concepts of conventional topics in physics with illustrations from everyday living. Assumes no previous physics course. (Students who need this course to meet a curricular requirement may also need to register for PHYS 106L.) Prerequisite: MATH 094 or 096 or equivalent.

PHYS 106L **1 S** **Introduction to Physics Laboratory**

A laboratory emphasizing physical measurements for those curricula requiring

an introductory physics course with laboratory. One laboratory per week. Prerequisite or corequisite: PHYS 105.

LOWER-DIVISION COURSES:

PHYS 111+112+113 **4+4+4 F+W+S** **General Physics I, II, III**

A three-quarter standard sequence introducing the fundamental natural phenomena of the physical universe, with an emphasis on fundamental principles and methods of physics. Suitable for pre-professional students and also acceptable as part of the general-education requirement in basic science. Three lectures and one laboratory per week. Must be taken in sequence. Prerequisite: Knowledge of algebra and trigonometry at the level provided by MATH 106 and 113.

PHYS 111: Newtonian mechanics, fluids, waves and vibrations, and sound.

PHYS 112: Kinetic theory, thermodynamics, electricity, and magnetism.

PHYS 113: Optics, atomic and nuclear physics, elementary particle physics, and special relativity.

PHYS 265 **3 S** **Calculus Applications for Physics**

Derivations and applications of fundamental physical principles commonly covered in General Physics using differential and integral calculus. Completing the PHYS 111-112-113 General Physics sequence and this course will be considered equivalent to a Physics with Calculus sequence. Prerequisite: MATH 131 and Corequisite: PHYS 113; OR Prerequisite MATH 267.

PHYS 280 **1 Arranged** **Introduction to Physical Science** **Research Methods**

Introduction to the mathematical and laboratory methods used in the physical sciences, especially in the experimental physics laboratory setting. Familiarization with the safe operation of typical

laboratory systems such as high-voltage power supplies, lasers, gas and vacuum systems will be emphasized. Methods of displaying and communicating scientific data will also be discussed. Prerequisites: PHYS 112.

PHYS 290 **0.5 W** **Sophomore Seminar** (See also MATH 290)

Preparation of students for successful pursuit of opportunities in physics related fields of work and study. Includes an introduction to tools and resources used in physics work, CV/résumé writing, major portfolio preparation, and identifying/pursuing internships and research experiences for undergraduates (REUs). Graded S/F.

UPPER-DIVISION COURSES:

PHYS 314 **4 F** **Elementary Modern Physics**

An overview of the fundamentals of relativity and quantum physics and selected topics such as atomic and molecular physics, statistical mechanics, solid state physics, nuclear physics, and elementary particles. Three lectures and one laboratory per week. Prerequisites: PHYS 265.

PHYS 321 **3 W** **Biophysics**

For the upper-division physics student with adequate preparation in biology. Covers a variety of topics in which physical analysis and techniques are applied to study molecular and cellular phenomena. Prerequisites: BIOL 111+112+113, CHEM 113, PHYS 314. Even years.

PHYS 322 **3 S** **Medical Physics**

A continuation of PHYS 321. Includes the physical principles of radiology, diagnostic imaging, and nuclear medicine. Prerequisite PHYS 321. Even years.

PHYS 380 **1 Arranged**
Research in Physics

Building upon the research methods and concepts introduced in PHYS 280, this course provides research opportunities and experience with real science apparatus such as lasers, high field magnets, detectors, radioactive sources, and sophisticated electronics. Students will undertake directed research problems suited to their background and experience. Prerequisites- PHYS 280 or BIOL 222 or instructor permission. Repeatable for credit with maximum of 3 credits. Qualifies for IP grading.

PHYS 390 **3 Arranged**
History and Philosophy of Science
(See also PHIL 390)

The historical roots of modern science, the nature of scientific knowledge, its development and methodology, the impact of science on culture (and vice versa), and the influence of philosophical and theological concepts on science. Prerequisites: PHYS 105 or CHEM 101; PHIL 101 or demonstrated preparedness for course.

PHYS 445 **4 S**
Thermal Physics
(See also CHEM 451)

A statistical description of a system of particles. Different ensembles and their associated partition functions are emphasized and applied to various thermal systems. Prerequisites: CHEM 113, MATH 132, and PHYS 111. Even years.

PHYS 461+462 **3+3 W+S**
Quantum Mechanics I, II
(See also CHEM 461)

Quantum mechanics and atomic physics. Topics include wave packets, Schrödinger's equation and its solutions, operator methods, angular momentum, matrix representation, spin, perturbation theory, the hydrogen atom, and radiation by atoms. Prerequisites for PHYS 461: CHEM 113, MATH 132, and PHYS 111. Odd years.

PHYS 485 **3 Arranged**
Issues in Science and Religion
(See also PHIL 485)

The relationship and interaction between science and religion: epistemology, the methods, languages, scope and limitations of science and religion, problems of ethics and science. Prerequisites: PHYS 105, CHEM 101, or equivalent; PHIL 101 or demonstrated preparedness for course.

PHYS 486 **1-4 Arranged**
Special Topics in Physics

Study of a selected topic not covered elsewhere in the curriculum. Course content varies from year to year, with topics such as Solid State Physics, High Energy Physics, and Applied Optics. Repeatable for credit.

PHYS 492 **1 S**
Senior Seminar in Physics

Culminating educational experience for biophysics students as the final course needed to complete the biophysics curriculum. In addition to continuing the experience and activities provided in PHYS 380, students will present and/or publish their project's results. Qualifies for IP grading.

PHYS 495 **1-3 Arranged**
Independent Study

Properly qualified students majoring in physics may, with approval of the department chair, undertake an independent study of a topic suited to their background and experience. Repeatable to a maximum of 3 credits.

Statistics

LOWER-DIVISION COURSE:

STAT 222 **4 F, W, S, Su**
Introduction to Statistics

Descriptive statistics, graphical methods, basic concepts of probability, normal probability distributions, central limit theorem, hypothesis tests involving means and proportions, confidence intervals, introduction to correlation and regression, and chi-square testing. Examples from a wide variety of disciplines, including business, the social sciences, and the life sciences, to prepare students with varying backgrounds and interests to become intelligent consumers and users of statistics. Prerequisites: MATH 094 or MATH 096 (D- or above) or equivalent, ENGL 101.

UPPER-DIVISION COURSE:

STAT 322 **3 W**
Statistical Methods

An intermediate course in applied statistics including multiple regression, analysis of variance, and nonparametric methods. Spreadsheets and statistical software are used to perform calculations. Prerequisite: STAT 222.