Mathematics

A degree in mathematics is an excellent means of preparation for post-college years, whether a student intends to work in business or industry, teach, or pursue graduate studies. At CLU we provide a broad and challenging program designed to develop fundamental skills and to prepare students for lifelong learning. The program features small classes with an emphasis on faculty-student interaction, classroom technology to facilitate learning, computer labs for student exploration and discovery, and a focus on interdisciplinary applications. Faculty mentors assist students in reaching their academic and career goals. Students are challenged to explore the many facets of mathematics and its applications through creative and critical thinking. Departmental space is set aside as a study and resource area for majors. Free tutoring for lower division courses is provided in the Math Lab.

The faculty encourage students to apply their mathematical knowledge by participating in internships, carrying out independent projects, and tutoring in the Math Lab. Students synthesize and extend their mathematical experiences in the senior capstone course. Other opportunities include participating in paid summer research programs across the nation, spending a semester studying mathematics abroad, preparing for and competing in national mathematics-related contests, and preparing posters and presentations for seminars and regional or national conferences.

Employers in the public and private sectors seek generalists with critical thinking skills who are capable of adapting to a wide variety of situations. Graduates in mathematics are prepared in this manner and can work in many career fields. These include computer science, engineering, actuarial science, education, business, finance and the natural sciences. Along with finding excellent employment opportunities, CLU math majors have also been accepted for graduate studies at top universities throughout the United States.

Students who wish to register for a mathematics course must meet the necessary prerequisites, as stated in the Schedule of Classes and the Undergraduate Catalog. Students unsure of whether they meet the prerequisites should contact a mathematics faculty member. Courses numbered 400 and above are best taken after or concurrently with a 300-level course.

All CLU students are required to meet the Mathematical Reasoning Proficiency under Core 21. Students who meet the proficiency requirement may still need to meet specific mathematics requirements for their majors

Major Requirements

Only mathematics courses numbered 200 or above earn credit toward a major in mathematics.

Bachelor of Science in Mathematics

45 credits minimum, 25 credits upper division.

MATH 241	Discrete Mathematics	4
MATH 251	Calculus I (preferred)	4
or MATH 245	Applied Calculus	
MATH 252	Calculus II	4
MATH 261	Calculus III	4
MATH 320	Elementary Mathematical Analysis	4
or MATH 382	Number Theory	
MATH 420	Real Analysis	4
or MATH 425	Abstract Algebra	
One 4-credit elective (upper or lower divsion)		4
Four 4-credit upper division mathematics classes (one class may be 3-credits instead)		15-16
MATH 475	Capstone	2
Total Hours		45-46

Required Supporting Courses

PHYS 211/211L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab	5
PHYS 212/212L	Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab	5
Computer Programming course at the 200-level or above (choice must be approved by Math Advisor)		
CSC 210	Introduction to Computer Programming	4
or CSC 205	Programming for Scientists	
Total Hours		14

Recommended Supporting Courses

MATH 474	Capstone Preparation (strongly recommended)	2
CHEM 151/151L	General Chemistry and General Chemistry Lab	5
CHEM 152/152L	General Chemistry II and General Chemistry II Lab	5
Total Hours		12

Bachelor of Arts in Mathematics

41 credits minimum, 21 credits upper division.

MATH 241	Discrete Mathematics	4
MATH 251	Calculus I (preferred)	4
or MATH 245	Applied Calculus	
MATH 252	Calculus II	4
MATH 261	Calculus III	4
Take at least two of the following three courses		8
MATH 320	Elementary Mathematical Analysis	
MATH 381	Geometry	
MATH 382	Number Theory	
One 4-credit math elective (upper or lower division)		4
Three additional 4- credit upper division mathematics classes (one of which may be only 3-credits)		11-12
MATH 475	Capstone	2
Total Hours		41-42

Required Supporting Courses

One mathematical perspectives course (can be a Math upper divsion elective, must be approved by Math advisor)		3-4
Complete one of the following two course sequence options		9-10
Physics Option		
PHYS 211/211L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab	
PHYS 212/212L	Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab	
Economics Option		
ECON 203	General Economics	
One of the following 400-level Economics classes		
ECON 406	Intermediate Macro-Economics	
ECON 411	Intermediate Micro-Economics	
or ECON 450	Econometrics	
Total Hours		12-14

Recommended Supporting Courses

MATH 474	Capstone Preparation (Strongly Recommended)	2
A course in Computer Programming at the 200-level or above		3-4
CSC 210	Introduction to Computer Programming	
or CSC 205	Programming for Scientists	
CHEM 151/151L	General Chemistry and General Chemistry Lab	5
CHEM 152/152L	General Chemistry II and General Chemistry II Lab	5
Total Hours		15-16

Minor in Mathematics

20 credits minimum, 8 credits upper division.

Only mathematics courses numbered 200 or above earn credit toward a minor in mathematics. Either MATH 245 or MATH 251 (preferred) may be counted toward the minor, but not both.

MATH 251	Calculus I	4
or MATH 245	Applied Calculus	
MATH 252	Calculus II	4
Two 4-credit upper division mathematics classes		8
Select one of the following:		4
MATH 241	Discrete Mathematics	
MATH 261	Calculus III	
MATH 265	Differential Equations	
4-credit upper division mathematics class		
Total Hours		20

Requirements for the Mathematics Single Subject Program

Students considering a career as a teacher of mathematics in a California high school or middle school should consider completing the CLU Mathematics Single Subject Program which is an approved subject matter program for the California Commission on Teacher Credentialing. Completion of this program allows a student to enroll directly in a teaching credential program upon graduation. Program requirements most closely match the B.S. in Mathematics degree, include an entrance interview after completing Calculus II, and a portfolio defense at the end. Students interested in entering the program should discuss program requirements with the director of the Mathematics Single Subject Program.

Honors in Mathematics

Nomination Process

Students interested in completing Departmental Honors must be nominated by a Math faculty member prior to their final year. This normally will occur three semesters before graduation, but might occur two semesters before. In order to be eligible for nomination a student must satisfy all three of the following requirements:

1. A Math GPA of at least 3.5 with no semester grade below a B in any upper division Math course,
2. An overall GPA of 3.0,
3. 2 upper division Math courses either *completed or in progress*.

Selection Process

Once nominated, a student takes MATH 474 Capstone Prep and develops a proposal for an Honors Project. The project proposal must follow the guidelines for Capstone in Mathematics projects but must be for a year-long project that holds the promise of completing publishable results. After the oral and written project proposals have been reviewed, the Math faculty will determine if a student's project is worthy of being selected as an Honors project. Moreover, by the time the candidate is selected he/she must also have *completed* at least 2 Upper Division Math courses with a grade of B or higher in both, and have at least 1 additional upper division Math course *completed or in progress*.

Completion of Departmental Honors

To complete Departmental Honors students must successfully pass all of the following courses:

- MATH 474 - Capstone Prep --2 credits (taken spring of Junior year)
- MATH 475 – Capstone--2 credits (taken fall of Senior year)
- MATH 497 - Honors Research--3 credits (taken Spring of Senior year)

This is equivalent to one year of mentored research experience, plus one semester of research preparation in the Capstone Prep course. The final project will be presented in three venues: a written thesis, an oral presentation, and a poster presentation. The advisor in conjunction with Math faculty will review the project at the end of the Capstone course to determine if the student may proceed with the Honors Research course. At the end of the Honors Research course they will again confer to determine if the project meets the standards of an honors project.

Courses

Lower Division

MATH 110. Intermediate Algebra. (4).
This course covers equations and inequalities, polynomials, rational and radical expressions, exponents, graphing linear equations and inequalities, linear systems, exponential and logarithmic functions, and places extensive emphasis on word problems. This course is appropriate for students with Math SAT 500 or below.

MATH 115. Finite Mathematics. (4).
This course studies the elementary models in business and social sciences including systems of linear equations and inequalities, matrices, interest, annuities and an introduction to probability and statistics. Recommended for business and social science majors. Prerequisite: MATH 110 or Math SAT 510 or above.

MATH 120. Concepts Underlying Arithmetic. (4).
This course is designed for the prospective elementary school teacher, and emphasis is on developing a deep understanding of the mathematical ideas necessary for superb teaching of elementary school mathematics. Communication of these ideas through appropriate language and the use of diagrams, patterns, and everyday objects is a critical feature of the class. Students are expected to work in cooperative groups during class, and to make presentations on a regular basis. Topics include number sense, representations of numbers, number systems, creating and analyzing algorithms for arithmetic operations, proportional reasoning, problem solving, algebraic thinking, and current California state math standards. Issues of access and pedagogy are addressed both individually and in the context of the mathematical ideas. This course does not satisfy the Core 21 Mathematical Reasoning Requirement. Prerequisites: MATH 110 with D- or above, or Math SAT 510 or above.

MATH 128. Topics in Liberal Arts Math. (4).
This course engages the students in an exploration of the nature of mathematics as well as a selection of mathematical topics chosen to illustrate why mathematics is one of the original liberal arts. An emphasis is placed on problem solving and communication of ideas through writing and class discussions. The nature of mathematics as well as two-, three- and four-dimensional geometry, and probability and statistics will be included each semester. Other topics will be chosen by the instructor. Prerequisite: MATH 110 or Math SAT 510 or above.

MATH 145. Business Mathematics. (4).
This course studies the elementary models of mathematics in business settings including the use of functions to model concepts such as revenue and profit, as well as interest and annuities. Additional topics include linear regression, decision trees, and an introduction to probability and statistics. Recommended for Business majors. Prerequisite: MATH 110 or Math SAT 500 or above.

MATH 151. Precalculus. (4).
This course studies real numbers, equations, inequalities and polynomial, rational, exponential, logarithmic and trigonometric functions. Prerequisite: MATH 110 or Math SAT 510 or above.

MATH 231. Biostatistics. (4).
This course introduces the principles, methods of reasoning, summarization, analysis and presentation of biological and biomedical data. Computer laboratory sessions are included to facilitate data handling and analysis. Topics include sampling and experimental design, descriptive statistics, probability, statistical inference and interpretation of results, simple regression and clinical trials. Prerequisite: MATH 151 or Math SAT 600 or above. (offered in spring).

MATH 241. Discrete Mathematics. (4).
Topics include set theory, number systems, the nature of proofs, recursion, algorithms, graph theory and problem solving. This course is required for computer science and computer information systems majors. Prerequisite: MATH 151 or Math SAT 600 or above. (offered in fall).

MATH 245. Applied Calculus. (4).
This course examines methods of mathematics used in business and economics, with a focus on problem solving and applications. It includes the ideas of differential calculus, including applications to marginal analysis (cost, revenue, profit), the elasticity of demand, and optimization. Concepts of integration up through substitution are included. Optimization is further examined through systems of linear equations and matrices, linear programming and a brief introduction to game theory. Required for Business Majors. Prerequisite: MATH 115, MATH 145 or Math SAT 600 or above.

MATH 251. Calculus I. (4).
Studies the concepts of the limit, the derivative and the definite integral of functions of one variable. Included are applications to rates and areas, differentials and basic modeling. A weekly computer lab is a key component of the course. Prerequisite: MATH 151 or Math SAT 600 or above.

MATH 252. Calculus II. (4).
This course continues the study of differentiation and integration begun in Calculus I. Introduces indefinite integration and applications of the definite integral. Differential equations and elementary methods to solve them are presented, along with direction fields and some modeling applications. Includes Taylor polynomials and series. A weekly computer lab is a key component of the course. Prerequisite: MATH 251.

MATH 261. Calculus III. (4).
Calculus III extends the concepts of calculus to a multivariable perspective. Topics such as functions, derivatives, integrals and various coordinate systems are used to explore change modeled by two or more variables. Vector algebra and vector fields are introduced to study the motion of objects. A weekly computer laboratory session facilitates exploration, visualization and reinforcement of the main topics of the course. Prerequisite: MATH 252. (offered in fall).

MATH 265. Differential Equations. (4).
Focuses on the formulation of appropriate mathematical models to represent phenomena, the solution (when possible) of such equations, and understanding and interpreting the solutions of these equations. Graphical and analytical methods will be explored, as will numerical techniques. Prerequisite: MATH 252. Recommended: MATH 261. (offered in spring).

MATH 282. Selected Topics. (4).

MATH 282C. ST: Select Topic (core). (1-4).
Select Topic approved for Core requirement.

Upper Division

MATH 320. Elementary Mathematical Analysis. (4).
An introduction to mathematical analysis emphasizing conjecture and proof. Content includes elementary logic and quantifiers, manipulations with sets, relations and functions, properties of the real number system, supremums and infimums, sequences and limits of sequences, and the topology of the real line. The course will introduce students to the concepts and techniques of mathematical proof. Prerequisite: MATH 252, Recommended: MATH 241.

MATH 343. Linear Algebra. (4).
An introduction to solving systems of linear equations through the use of concepts such as vector spaces, linear transformations, matrices, eigenvalues and eigenvectors. Students will enhance mathematical communication skills through reading and writing proofs and will explore interdisciplinary applications of the theory of linear algebra in projects and computer laboratory assignments. Prerequisite: MATH 252. Recommended: MATH 261.

MATH 352. Probability and Statistics I. (4).
This course covers topics including methods of data description, probability theory, a study of several discrete and continuous distributions, the central limit theorem, estimation of parameters, confidence intervals and hypothesis testing. Prerequisite: MATH 252. Recommended: MATH 261.

MATH 381. Geometry. (4).
This course primarily investigates the integration of geometries on the plane, sphere and hyperbolic plane. An emphasis is placed on experiencing the meanings in the geometry. Student investigations, small-group learning and writing assignments will be used to explore geometrical ideas. The history and culture of mathematics, particularly as reflected by the development of geometrical understanding, will be threaded through the course. Prerequisite: MATH 252. Recommended: MATH 261 and MATH 343.

MATH 382. Number Theory. (4).
This course focuses on the properties of integers and the history of the discovery of these properties. Topics include fundamental theorems on divisibility, primes and congruences, as well as number-theoretical functions, Diophantine equations, quadratic reciprocity and Fermat's Last Theorem. This course will introduce students to the concepts and techniques of mathematical proof. Prerequisite: MATH 252 or consent of instructor. Recommended: MATH 241.

MATH 420. Real Analysis. (4).
A study of the real number system, set theory, sequences, functions, continuity, differentiation and Riemann-Stieltjes integration, with an emphasis on developing the ability to communicate mathematically. Prerequisite: MATH 261 and either MATH 382 or MATH 320 (preferred).

MATH 425. Abstract Algebra. (4).
Studies the theory of integers, groups, rings, fields and polynomials. Prerequisite: MATH 241 and either MATH 382 (preferred) or MATH 320.

MATH 440. Mathematical Methods of Physics. (4).
Mathematics with a focus to meet the needs of students with a major or minor in physics or engineering disciplines. Topics include: complex variables, linear algebra, coordinate transformations, vector analysis, Fourier series and transforms; Laplace transforms, the Dirac delta function, Green functions, calculus of variations and solution techniques for partial differential equations with specific applications to Laplace's equation. Prerequisites: MATH 261 and PHYS 212. Recommended: MATH 265. (Cross-listed with PHYS 440).

MATH 450. Complex Analysis. (4).
Topics include complex numbers and functions, analytic functions, differentiation, integration, series, contour integrals and conformal mapping. Prerequisite: MATH 261 and one other upper division mathematics course.

MATH 452. Probability and Statistics II. (4).
This course extends the concepts of probability and statistics through a multivariable perspective. Students study statistical models through topics such as experimental design, regression, analysis of variance, contingency tables and order statistics. Data handling and analysis are conducted with the aid of statistical software. Prerequisites: MATH 261 and MATH 352.

MATH 471. Mathematical Modeling. (4).
A speaking-intensive introduction to modeling techniques, synthesizing concepts and methods learned in previous courses. Applications will be chosen from various disciplines (particularly science, social science, business and education), environmental resource issues and scheduling/allocation. Techniques used will include computer simulation, game theory, difference equations and/or differential equations and probabilistic models or statistical models. Prerequisites: MATH 265. Recommended prerequisites: MATH 352 and a course in computer programming.

MATH 474. Capstone Preparation. (2).
Whether in industry, graduate school, or in your capstone project, skills in formulating answerable questions, identifying relevant sources, and locating helpful ideas is important. This course investigates the diversity of mathematical topics, skills for researching the topics, and the components of a project proposal. The course culminates in a written and oral presentation of a project proposal. Prerequisite: Mathematics major or minor and Junior standing. (offered in spring).

MATH 475. Capstone. (2).
The capstone in mathematics is intentionally open-ended. The focus of the course centers on the mathematics majors designing and carrying out individual projects suited to their interests and post-graduation goals. Weekly class meetings will be run in seminar fashion: each student will be expected to present at least one report on a) the culture of mathematics, b) the relationship between mathematics and other disciplines or career avenues or c) a moral/ethical issue related to mathematics. Prerequisite: senior standing.

MATH 482. Selected Topics. (1-4).

MATH 482C. ST: Select topic (core). (1-4).
Select Topic approved for core requirement.

MATH 485. Seminar. (2-4).

MATH 490. Independent Study. (1-4).

MATH 492. Internship. (1-4).
(graded P/NC only).

MATH 496. Directed Research. (1-3).

MATH 497. Honors Research. (3).