The Mathematics Major

Mathematics is an essential component of the traditional liberal arts. From their inception in Greek thought, the liberal arts included arithmetic and geometry. In the medieval grouping of the liberal arts into trivium and quadrivium, the latter four were considered intrinsically mathematical in nature. The ancient Greeks and medieval schoolmen considered mathematics as a propadeutic for higher studies. The abstraction, formality, and rigor of mathematical reasoning instill in the student habits of logic, precision, clarity, and patience. The study of mathematical objects disposes the student to the existence of immaterial forms. The structure of mathematics reveals an order and beauty in the universe. These aspects of mathematics help to prepare the student for the study of the physical sciences, the social sciences, philosophy, and theology, as well as deeper investigations into mathematics itself.

The mathematics program aims to convey three distinct aspects of mathematics to diverse constituencies in the University. Mathematics is: a mode of formal reasoning in the tradition of the quadrivium; a practical art in application to the quantitative sciences; a discipline in its own right.

The mathematics program develops a student's understanding of the nature, power, scope, and beauty of mathematical thought within a Catholic liberal arts tradition. The mathematics curriculum provides students with a solid foundation in theoretical, practical, and computational aspects of the discipline. The mathematics major, in conjunction with the integrated Core Curriculum, forms habits of mind and hones intellectual skills that equip the student for a lifetime of learning. With a judicious choice of electives and an appropriate minor, the mathematics major can prepare a student for a wide spectrum of vocations.

The Mathematics Core

The mathematics core requirement is typically satisfied in the freshman year. The University uses a placement protocol, which includes a mathematics placement exam, to assist students in the selection of a suitable core course from the list below.

Core Courses (one required)
MATH 100 Number, Magnitude, Form
MATH 120 Finite Mathematics
MATH 150 Functions
MATH 151 Calculus I

The Mathematics Major

The mathematics major consists of seven required mathematics courses, four elective mathematics courses, and two required physics courses. At the discretion of the department, students may receive Advanced Placement credit or transfer credit for courses. Highly motivated mathematics students are encouraged to participate in undergraduate research under the guidance of a faculty member.

Required Major Courses
MATH 151 Calculus I
MATH 250 Calculus II
MATH 251 Vector Calculus
MATH 270 Scientific Programming
MATH 310 Algebraic Structures

MATH 330 Probability
MATH 490 Senior Seminar

Required Core Science Courses
PHYS 221 University Physics I
PHYS 222 University Physics II

Elective Major Courses (four required)
MATH 201 History of Mathematics
MATH 230 Statistics
MATH 252 Ordinary Differential Equations
MATH 311 Linear Structures
MATH 312 Number Theory
MATH 350 Real Analysis
MATH 351 Complex Analysis
MATH 352 Partial Differential Equations
MATH 360 Differential Geometry
MATH 491 Undergraduate Research

Minor in Mathematics

The mathematics minor program consists of a total of at least six courses in mathematics. MATH 150 Functions may count as one of the six, whereas MATH 120 Finite Mathematics and MATH 100 Number, Magnitude and Form may not.

Minor in Physics

The physics minor program is intended to serve students who are interested in academic preparation for a technical or academic career, and as such enlarges the scope of the mathematics program. The physics minor consists of a total of at least six courses in physics selected from the lists that follow.

Required Physics Minor Courses
PHYS 221 University Physics I (satisfies the Core science requirement)
PHYS 222 University Physics II (satisfies the Core science requirement)
PHYS 323 University Physics III

Elective Physics Minor Courses (three required)
PHYS 330 Intermediate Mechanics
PHYS 341 Thermodynamics and Statistical Mechanics
PHYS 350 Electricity and Magnetism
PHYS 361 Quantum Mechanics I
PHYS 362 Quantum Mechanics II

Course Descriptions

MATH 100 NUMBER, MAGNITUDE, FORM
The development of the concepts of number, magnitude, and form in mathematics. Topics include the natural numbers, the real numbers, and transfinite numbers; length, area, volume, dimension, and fractals; and knots. Emphasis is on the understanding of ideas and the ability to express them through mathematical arguments.

MATH 120 FINITE MATHEMATICS
Application of quantitative tools as an aid to problem solving in a variety of areas. Topics include solution techniques for systems of linear equations and inequalities,

basic principles of probability and statistics, elementary finance, Markov chains, matrices, and more.

MATH 150 FUNCTIONS
A survey of the fundamental mathematical functions and their applications including the linear, absolute value, polynomial, rational, exponential, logarithmic, and trigonometric functions.

MATH 151 CALCULUS I
Differential and elementary integral calculus of functions of one variable. Topics include limits, continuity, derivatives, linear approximation, the Fundamental Theorem of Calculus, and elementary techniques of integration. MATH 150 or placement required.

MATH 201 HISTORY OF MATHEMATICS
The history of mathematics from its origins to the present with an emphasis on significant problems and their solutions. MATH 151 or permission of instructor required.

MATH 230 STATISTICS
Introduction to statistical inference. Basic probability, descriptive statistics, sampling distributions, parameter estimation, tests of hypotheses, chi-square tests, regression analysis, analysis of variance, and nonparametric tests. MATH 150 required. Crosslisted with ECON 303.

MATH 250 CALCULUS II
Continuation and extension of Calculus I. Topics include more advanced integration techniques, improper integrals, sequences, series, Taylor series, functions of several variables, partial derivatives, multiple integration. MATH 151 required.

MATH 251 VECTOR CALCULUS
Calculus of functions in several variables. Topics include the geometry of Euclidean space, vector algebra, forms, matrices, vector-valued functions, the Inverse and Implicit Function Theorems, line and surface integrals, differential forms, and the theorems of Green, Gauss, and Stokes. Applications to physics. MATH 250 required.

MATH 252 ORDINARY DIFFERENTIAL EQUATIONS.
An introduction to the theory of ordinary differential equations with an emphasis on methods of solution. Topics include first-order equations, existence and uniqueness, linear equations, equations with constant coefficients, variation of parameters, Laplace transforms, series solutions, systems of equations, numerical methods. MATH 250 required.

MATH 270 SCIENTIFIC PROGRAMMING
An introduction to programming via the solution of various problems in mathematics and the sciences. Problem description, development of a model, creation and implementation of a computational method of solution, and assessment of results. MATH 150 required.

MATH 310 ALGEBRAIC STRUCTURES
An introduction to abstract algebra. Topics include groups, subgroups, quotient groups, homomorphisms, rings, ideals, fields. Emphasis on constructing, writing, and presenting proofs. MATH 251 required.

MATH 311 LINEAR STRUCTURES
A study of abstract linear algebra. Topics include vector spaces, linear transformations, matrices, eigen values, canonical forms, inner product spaces, modules. MATH 310 required.

MATH 312 NUMBER THEORY
A study of the basic properties of the integers including divisibility, primes and their distribution, unique factorization, the Euclidean algorithm, congruences, primitive roots, arithmetic functions, quadratic reciprocity, Diophantine equations, and other topics. MATH 310 required.

MATH 330 PROBABILITY
An introduction to probability theory. Topics include sample spaces, discrete and continuous random variables, density functions, moment generating functions, probability distributions, and the Central Limit Theorem. MATH 250 required.

MATH 350 REAL ANALYSIS
A rigorous study of the theoretical structure of calculus including the real numbers, metric spaces, limits, continuity, differentiation, integration, the Fundamental Theorem of Calculus, infinite series, and power series. MATH 310 required.

MATH 351 COMPLEX ANALYSIS
An introduction to the study of functions of a complex variable. Topics include the complex numbers, analytic functions, the elementary functions, complex integration, Taylor and Laurent series, residues, conformal mapping, and applications. MATH 251 required.

MATH 352 PARTIAL DIFFERENTIAL EQUATIONS
An introduction to second-order partial differential equations in two variables. Topics include wave motion and Fourier series, heat flow and the Fourier integral, Laplace's equation and complex variables, second-order equations in more than two variables, spherical harmonics, and associated special functions of mathematical physics. MATH 252 required.

MATH 360 DIFFERENTIAL GEOMETRY
A classical treatment of the differential geometry of curves and surfaces in three-dimensional space. Topics include: Frenet frames, the local theory of parameterized curves, regular surfaces, tangent planes, first and second fundamental forms, the Gauss map, parallel transport and the Gauss-Bonnet Theorem. MATH 251 required.

MATH 490 SENIOR SEMINAR
Student presentations of selected mathematical problems and directed readings. Senior status required.

MATH 491 UNDERGRADUATE RESEARCH
Student-Faculty collaboration on research projects of mutual interest. Permission of the department required.

Physics Courses

PHYS 201 PHYSICS OF EVERYDAY LIFE (with lab)
This course is a one-semester introduction to physics. Common machines, devices, and everyday phenomena are used as examples to illustrate underlying physical principles. Working knowledge of algebra and geometry is assumed.

Mathematics

PHYS 211 COLLEGE PHYSICS I (with lab)
Mechanics is foundational to physics. Topics include: rectilinear and rotational motions of particles and rigid bodies, forces, energy methods, conservation laws, and oscillations and waves. MATH 150 required.

PHYS 212 COLLEGE PHYSICS II (with lab)
Thermodynamics, electricity and magnetism, and optics are essential aspects of classical physics. Topics include: temperature, heat and its transfer, the Laws of Thermodynamics, electric force, field, potential and current, capacitance, resistance, induction, circuits, and optics. MATH 150 required.

PHYS 221 UNIVERSITY PHYSICS I (with lab)
Mechanics is foundational to physics. Topics include: rectilinear and rotational motions of particles and rigid bodies, forces, energy methods, conservation laws, and Newton's Law of Universal Gravitation. MATH 151 required.

PHYS 222 UNIVERSITY PHYSICS II (with lab)
Oscillatory and wave-like behavior is ubiquitous in nature. The production and flow of thermal energy, heat, is governed by the Laws of Thermodynamics. Topics include: materials, oscillations, waves, interference and diffraction, geometric optics, and the Laws of Thermodynamics. PHYS 221 required.

PHYS 323 UNIVERSITY PHYSICS III
Maxwell's unification of electricity and magnetism was a revolutionary development in classical physics. Topics include: electric force, field, potential and current, capacitance, resistance, induction, AC/DC circuits, and Maxwell's Equations along with their vacuum solutions. PHYS 221 and MATH 250 required.

PHYS 330 INTERMEDIATE MECHANICS
Topics include: central force potentials, Lagrangian and Hamiltonian formulations of dynamics, fluids. PHYS 323 required.

PHYS 341 THERMODYNAMICS AND STATISTICAL MECHANICS
Topics include: classical formulation of Thermodynamic Laws, kinetic theory, Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions and applications. PHYS 323 required.

PHYS 350 ELECTRICITY AND MAGNETISM I
Topics include: Maxwell's equations in differential form, electrodynamics, electromagnetic waves, special relativity. PHYS 323 required.

PHYS 361 QUANTUM MECHANICS I
Topics include: quantum operators, one-dimensional wells and barriers, Born interpretation, Schroedinger equation, uncertainty principle, central force problems, angular momentum and spin, addition of angular momenta. PHYS 323 or permission of instructor required.

PHYS 362 QUANTUM MECHANICS II
Topics include: fermions and bosons, perturbation theory (time independent and time dependent), variational methods, WKB approximation, scattering. PHYS 361 required.

Typical Plan—Mathematics Major

Freshman Year

Fall Semester	Credits	Spring Semester	Credits
MATH 151 Calculus I	4	MATH Calculus II	4
LITR 103 Literary Tradition I	4	LITR 104 Literary Tradition II	4
HIST 101 Western Civ I	4	HIST 102 Western Civ II	4
LATN 101 or 103 Elem Latin	4	LATN 102 or 104 Inter Latin	4
MUSC 101 Gregorian Chant*	0		
Total	16	Total	16

*may be taken in the Fall or Spring semester.

Sophomore Year

Fall Semester	Credits	Spring Semester	Credits
PHIL 205 Nature and Person	4	PHIL 206 Ethics	4
THEO 105 Sacred Scripture	4	THEO 205 Sacred Doctrine	4
PHYS 221 Univ Physics w/ lab	4	PHYS 222 Univ Physics w/ lab	4
MATH 251 Vector Calculus	4	MATH 270 Scientific Program	4
Second Arts Practicum*	0		0
Total	16	Total	16

*may be taken in the Fall or Spring semester.

Junior Year

Fall Semester	Credits	Spring Semester	Credits
MATH 310 Algebraic Structure	4	HIST/POLT 203 Amer Civ	4
Math Elective	4	MATH 330 Probability	4
General Elective	4	Math Elective	4
General Elective	4	General Elective	4
Total	16	Total	16

Senior Year

Fall Semester	Credits	Spring Semester	Credits
MATH 490 Senior Seminar	4	Math Elective	4
Math Elective	4	THEO 400 Living in Christ	4
General Elective	4	PHIL 400 Phil Perspectives	4
General Elective	4	General Elective	4
Total	16	Total	16