Pass/Fail only. Variable credit.

LA 310 Project Research
After the student's topic and form for the academic project is approved by the Liberal Arts faculty, this independent research is required. The student works under the supervision of the first reader who services as a mentor in the research project. Forms, strategies and approaches are considered and shaped as the topic dictates; concrete results are required, usually in the appearance of a substantial rough draft. Three credits.

LA 325 Senior Seminar for Liberal Arts Majors
This course is designed for the student who is in the final stages of the Liberal Arts Project. The course will utilize a workshop format and class meetings will focus on the stylistic and technical aspects of the senior project. Fall semester. Variable credit.

LA 350 Independent Study
May be repeated. Variable credit.

LA 550 Cooperative Education — Liberal Arts Internship
Professional work experience in the community which complements and strengthens academic in-class learning. Academic credit is variable depending on the nature and duration of the experience. Students may or may not be compensated depending on the company/agency. Students must receive departmental approval to participate. May be repeated. Variable credit.

Mathematics

Michael W. Botsko, **Chairperson**
Richard Gosser; Norman W. Hipps, O.S.B.; Larry J. Mismas; Harry Morrison

Adjunct Faculty: Donna Botsko, Rachel Kurdziel, James Novak, Dawn Turkovich

Mathematics, the study of numbers and shapes, and the language of the physical sciences, has emerged from its classical roots as the principle tool for the analysis and comprehension of many current problems. Chaos and fractals, cryptography, data compression algorithms, tomography, and turbulence are only a few of the many areas currently studied by mathematicians. In addition, promising research continues to be done in the fields of Analysis, Topology, Algebra, and Number Theory. These exciting areas of study all utilize the fundamentals of mathematics within a rigorous logical structure.

The Department of Mathematics prepares the student by teaching the ability to comprehend and use the language of mathematics. Students will come to appreciate the logical structure and beauty of the mathematical development. The student will come to formulate the needed mathematical methods to analyze and solve real problems.

The courses offered prepare mathematics majors for graduate studies, research, engineering, teaching, and positions in industry and government. They also provide the necessary background for students in engineering and the social and physical sciences. Finally, the courses allow for the study of mathematics for its own sake.

As a culminating activity mathematics majors must take Abstract Algebra I or Real Analysis I during the first semester of their senior year. The following charts give the course schedule for students pursuing either a Bachelor of Arts degree or a Bachelor of Science degree in Mathematics.

Teacher Preparation

Departmental requirements: four credits each of physics and chemistry, three credits of logic, three credits of ethics, three credits of fine arts, three credits of intermediate writing, three credits of literature and the following courses in mathematics: MA 111,112, 113, 114, 115, 201, 206, 208 and MA 210.

Students who want to elect the teacher certification option must contact the Chairperson of the Education Department at their earliest possible convenience. Additional information is given under the Education Department.

Requirements for a Bachelor of Arts Degree in Mathematics
(See Core Curriculum requirements.)

Major Requirements (58 credits)

MA 111-112	Calculus I**, II	8
MA 113	Calculus III	4
MA 114	Ordinary and Partial Differential Equations	4
MA 115	Linear Algebra	3
MA 201-202	Abstract Algebra I, II	6
MA 203	Complex Variables	3
MA 204	Topology	3
MA 206-207	Real Analysis I, II	8
PH 111-112	General Physics I, II*	6
PH 113-114	General Physics Laboratory I, II*	2
CH 101-103	General Chemistry I and Laboratory#	4
CH 102-104	General Chemistry II and Laboratory	4
CS 110	Computing and Information Science I	3

*General Physics I with Laboratory fulfills a Core Curriculum requirement. #General Chemistry I with laboratory also fulfills a Core Curriculum requirement. ** Calculus I is a 4 credit course with 3 credits fulfilling the mathematics core.

Suggested Electives

BA 100-101	Elementary Accounting I, II	6
CS 170	Discrete Structures I	3
CS 270	Introduction to Numerical Computation	3

The schedule listed below is intended as a guide to help students plan courses.

Requirements for a Bachelor of Science Degree in Mathematics.
(See Core Curriculum requirements.)
Major Requirements (61 credits)

MA 111-112	Calculus I**, II	8
MA 113	Calculus III	4
MA 114	Ordinary and Partial Differential Equations	4
MA 115	Linear Algebra	3
MA 201-202	Abstract Algebra I, II	6
MA 203	Complex Variables	3
MA 204	Topology	3
MA 206-207	Real Analysis I, II	8
MA 208	Probability and Statistics	3
or		
MA 223	Mechanics: Statics	3
PH 111-112	General Physics I, II*	6
PH 113-114	General Physics Laboratory I, II*	2
CH 101, 103	General Chemistry I and Laboratory	4
CH 102, 104	General Chemistry II and Laboratory	4
CS 110	Computing and Information Science I	3

*General Physics I with Laboratory fulfills a Core Curriculum requirement.
#General Chemistry I with laboratory also fulfills a Core Curriculum requirement.
** Calculus I is a 4 credit course with 3 credits fulfilling the mathematics core.

Suggested Electives

BA 100-101	Elementary Accounting I, II	6
CS 170	Discrete Structures	3
CS 270	Introduction to Numerical Computation	3

Requirements for Minor in Mathematics (18 credits)

MA 111	Calculus I	4
MA 112	Calculus II	4
MA 113	Calculus III	4

Two courses elected from the following list, one of which must not be in Analysis*.

MA 114	**Ordinary and Partial Differential Equations**	**4**
MA 115	Linear Algebra	3
MA 201	Abstract Algebra I	3
MA 202	Abstract Algebra II	3
MA 203	**Complex Variables**	**3**
MA 204	**Topology**	**3**
MA 206	**Real Analysis I**	**4**
MA 207	**Real Analysis II**	**4**
MA 208	Probability and Statistics	3

*The courses in bold are in the field of Analysis.

The schedule listed below is intended as a guide to help students plan courses.

Typical Freshman Year Schedule
Fall Semester

MA 111	Calculus I	4
CH 101, 103	Chemistry	4
Intermediate Language I		3
EL 102	Language and Rhetoric	3 or in the spring
RS 119	Exploring Religious Meaning	3 or in the spring
History		3

All students will take one three (3) credit course designated as a Freshman Seminar which will satisfy a Core Curriculum requirement.

Spring Semester

MA 112	Calculus II (MA-112)	4
CH 102, 104	Chemistry 102, 104	4
Intermediate Language II		3
EL 102	Language and Rhetoric	3
or		
RS 119	Exploring Religious Meaning	3
History		3

Engineering

Saint Vincent College, in conjunction with University Schools of Engineering, offers a five-year cooperative liberal arts and engineering program. The student normally spends three years at Saint Vincent College, during which time studies concentrate on liberal arts subjects and the general science prerequisites for an engineering major, and then, in two years at the engineering college, fulfills the remaining engineering requirements. Upon satisfactory completion of all coursework at Saint Vincent College* and recommendation by the Mathematics Department, students are guaranteed of acceptance at Pennsylvania State University* * and at Boston University. Saint Vincent College also has formal agreements with the University of Pittsburgh and The Catholic University of America.*** Under these programs the University of Pittsburgh and The Catholic University of America each will admit up to eight qualified students from Saint Vincent College per year. At the University of Pittsburgh some departments may require Summer Term attendance prior to the student's first fall term at Pitt and/or an additional term or year of course work. Upon recommendation by the Mathematics Department, students have also been accepted at such schools as Carnegie-Mellon University, M.I.T., University of Detroit, Drexel University and Lehigh University.

Under this program the student receives two degrees: a Bachelor of Arts degree from Saint Vincent College and a Bachelor of Science degree in the appropriate branch of engineering from the engineering college. Students in the 3-2 engineering program may graduate from Saint Vincent College after successful completion of 45 credits from their engineering school excluding co-ops.

Academically superior students can complete a master's degree within the two-year period if they transfer to Boston University. The Master of Science, Master of Engineering, and a combined Master of Engineering and Master of Business Administration Degrees are offered at Boston University in the following disciplines: Aerospace Engineering, Applied Mechanics, Computer Engineering, Engineering (interdisciplinary), Manufacturing Engineering, Manufacturing Engineering and Business Administration, and Systems Engineering. The Master of Science in Engineering at Boston University is an interdisciplinary degree and is appropriate when the course of study involves coursework or research in several different departments. Typical Master of Science in Engineering programs might include important areas such as Biomedical Engineering, Electrical Engineering, Engineering Economic Systems, and Environmental Engineering.

The engineering colleges to which Saint Vincent students may transfer offer programs of courses leading to the degree of Bachelor of Science in Civil, Mechanical, Chemical[1], Electrical[2], Industrial[4], Mining[3], Petroleum[3], Aerospace, Bioengineering[5], Metallurgical, Civil[4], Computer Engineering, and others.

Students in the 3-2 Engineering Program are required to maintain a grade point average of 2.8 or above while at Saint Vincent College. In the event that the student drops from the engineering program before receiving an engineering degree, the student must return to Saint Vincent and follow the normal mathematics program in order to obtain a degree.

The 3-2 engineering student is required to complete the entire junior year at Saint Vincent and as a culminating activity must pass a comprehensive exam in the sixth semester.

* Students in the 3-2 Engineering Program are required to maintain

a grade point average of 2.8 or above while at Saint Vincent College.
* * Students transferring to Pennsylvania State University must maintain a grade point average of at least 3.00 at Saint Vincent College and a grade point average of 3.50 if desiring to major in Aerospace Engineering, Bioengineering, Computer Engineering, and Mechanical Engineering.

1 Students planning to major in Chemical Engineering should take Organic Chemistry: CH 221-224 and Physical Chemistry: CH 231.

2 Students intending to major in Electrical Engineering should take Electrical Circuits and Electronics: PH 251.

3 Students planning to major in Civil Engineering, Mining Engineering, or Petroleum Engineering should take Physical Geology: PH 106, 107.

4 Students planning to major in Civil Engineering, Industrial Engineering, or Mechanical Engineering at Penn State must take a course in strength of materials. Such students should also take Thermodynamics: PH 215.

5 Students intending to major in Bioengineering should take General Biology: BL150-152 and Organic Chemistry: CH 221, 223.
***Students transferring to The Catholic University of America will take one further course in religion and religious education beyond the three Religious Studies courses completed at Saint Vincent College.

The following charts list the requirements for a student participating in the 3-2 Engineering Program:

Requirements for a Bachelor of Arts Degree in Engineering/Liberal Arts.
Core Requirements (50 credits)

History	6
Philosophy I	3
Philosophy	3
Language and Rhetoric	3
English +	3
Exploring Religious Meaning	3
Religious Studies	3
Foreign Language	6
Social Studies	3
Economics	3
Natural Sciences*	8
Fine Arts	3
Mathematics*++	3

*Major requirements will fulfill the Natural Sciences and Mathematics requirement.
+Students transferring to Pennsylvania State University must take Technical Writing (EL 108). Such students must also take a three credit course in Speech. Students transferring to the University of Pittsburgh must take Principles of Literature (EL 103).
++Students transferring to the University of Pittsburgh should also take Probability and Statistics: MA 208.

Major Requirements (55 credits)

MA 111-112	Calculus I**, II	8
MA 113	Calculus III	4
MA 114	Ordinary and Partial Differential Equations	4
MA 115	Linear Algebra	3
MA 203	Complex Variables	3
MA 213	Seminar for Engineers	1
MA 221	Engineering Drawing	3
MA 223	Mechanics: Statics	3
MA 224	Mechanics: Dynamics	3
PH 111-112*	General Physics I, II	6
PH 113-114	General Physics Laboratory I, II	2
PH 211	Modern Physics	3
PH 213	Modern Physics Laboratory	1
CH 101, 103#	General Chemistry I and Laboratory	4
CH 102, 104	General Chemistry II and Laboratory	4
CS 270+	Introduction to Numerical Computation	3

*General Physics I with Laboratory fulfills a Core Curriculum requirement.
#General Chemistry I with laboratory also fulfills a Core Curriculum requirement.
** Calculus I is a 4 credit course with 3 credits fulfilling the mathematics core.
+Students who are planning to transfer to the University of Pittsburgh may take CS 110 instead of CS 270.

3-2 Engineering Program (B.A. only)

The schedule below is intended as a guide to help students plan courses.

Typical Freshman Year Schedule
Fall Semester

MA 111	Calculus I	4
CH 101	General Chemistry I	3
CH 103	General Chemistry I Laboratory	1
	Modern or Classical Language	3
RS 119	Exploring Religious Meaning	3
or		
EL 102	Language and Rhetoric	3
HI	History	3

All students will take one three (3) credit course designated as a Freshman Seminar which will satisfy a Core Curriculum requirement.

Spring Semester

MA 112	Calculus II	4
CH 102	General Chemistry II	3
CH 104	General Chemistry II Laboratory	1
	Modern or Classical Language	3
RS 119	Exploring Religious Meaning	3
or		
EL 102	Language and Rhetoric	3
HI	History	3

MA 100 Mathematical Overview
This course is designed to provide the student with an overview of algebraic concepts. The specific intention is to stress the understanding of content and of method so that algebra is had as a workable tool for ensuing math courses. Therefore, concepts of modern math form an integral part of the basic thrust of the course as it seeks to prepare the student to master the algebraic concepts presented. An algebra background is presupposed. Three credits.

MA 102 Mathematics for Teachers
A course designed specifically for prospective teachers in K -12 schools. The goal is to help students better comprehend and apply mathematical concepts and principles in the content strands of geometry, number systems, data analysis and statistics, and problem solving. Students will be introduced to a variety of materials, activities with physical manipulatives and computer models, and various types of software as tools for teaching and learning. The course focus will include emphasis from the national standards and Pennsylvania standards for mathematics as well as state standards for other certification areas that include application of mathematics in another subject area. Prerequisites: ED 100 and ED 205. Offered Spring semester. Three credits.

MA 104 Elementary Functions
This is a one-semester course whose main ideas are emphasized in the presentation of the polynomial, rational, trigonometric, exponential, and logarithmic functions. The core of the course is derived from materials best described as a compendium of college algebra, trigonometry, and analytic geometry, which would reinforce those skills essential to Calculus. Prerequisite: MA 100 or equivalent high school background. Three credits.

MA 109 Calculus I (for Biology and Social Science majors)
The elementary functions, limits, the derivative and its applications, the definite integral, techniques of integration. Applications are presented from the areas of biology and the social sciences. Graphing calculators and the computer algebra system of *Mathematica* are used to help study various concepts of calculus. Four credits.

MA 110 Calculus II (for Biology and Social Science majors)
Probability, vectors, partial differentiation, multiple integration, sequences and series. Graphing calculators and the computer algebra system of *Mathematica* are used to help study various concepts of calculus. Prerequisite: MA 109. Four credits.

MA 111 Calculus I
The real number system. Limits and continuity. The concepts of differentiation and integration. Differentiation of algebraic and trigonometric functions and applications. Newton's method. The Mean Value Theorem. The definite integral and the Fundamental Theorem of Calculus. Applications of the definite integral. Graphing calculators and the computer algebra system of *Mathematica* are used to help study various concepts of calculus. Four credits.

MA 112 Calculus II
The trigonometric, logarithmic and exponential functions. Polar coordinates and parametric equations. The calculus of vectors. Techniques of integration and further applications of the integral. Approximate integration. Prerequisite: MA 111. Four credits.

MA 113 Calculus III
Three-dimensional vectors and surfaces. Sequences and series. Multi-variable functions and partial differentiation. Double and triple integrals and applications. Prerequisite: MA 112. Four credits.

MA 114 Ordinary and Partial Differential Equations
First order equations and applications, classical and numerical methods; second order linear equations and applications; solution in series; Bessel's and Legendre's equations; Laplace transform solutions; higher order equations; introduction to partial differential equations, separation of variables and Fourier series. Prerequisite: MA 113. Four credits.

MA 115 Linear Algebra
Matrices and systems of linear equations. Vector spaces and linear transformations. Determinants. Inner product spaces, eigenvalues and eigenvectors. Prerequisite: MA 112. Three credits.

MA 201 Abstract Algebra I
Groups: normal subgroups and quotient groups, isomorphism theorems, Cayley's theorem. Rings: ideals and quotient rings, isomorphism theorems. Prerequisite: MA 114. Offered every other year. Three credits.

MA 202 Abstract Algebra II
Vector spaces, fields and field extensions, Galois Theory. Coding Theory. Prerequisite: MA 201. Three credits.

MA 203 Complex Variables
The complex number system the Cauchy-Riemann equations, contour integrals, the Cauchy integral theorem and formula, sequences, power series and Laurent series, residue theory and conformal mapping. Prerequisite: MA 113. Three credits.

MA 204 Topology
Sets, functions, metric spaces, topological spaces, connectedness, compactness, separation axioms, approximation, fixed point theorems. Prerequisite: MA 114. Offered every other year. Three credits.

MA 206 Real Analysis I
A rigorous study of calculus, limits of sequences and functions, the Full Cover Theorem, absolute continuity, differentiation, properties of differentiable functions, the Riemann integral. Lebesgue's Theorem, the Riemann-Stieltjes integral, the Lebesque integral, the Riemann-complete integral. Prerequisite: MA 114. Offered every other year. Four credits.

MA 207 Real Analysis II
Vector calculus functions of several variables, differentiability, transformations, and the Inversion Theorem, infinite series, series of functions, Fourier series. Prerequisite: MA 206. Four credits.

MA 208 Probability and Statistics
Discrete probability including such topics as independence, conditional probability, Bernoulli trials, and Bayes Theorem, Calculus of probabilities including random variables, discrete and continuous distributions, expectance and variance. Prerequisite: MA 113. Offered every other year. Three credits.

MA 210 Euclidean and Non-Euclidean Geometries
Elementary geometry from an advanced standpoint.
Non-Euclidean geometries, with emphasis on hyperbolic geometry. The postulation method. Prerequisite or concurrent course: MA 112. Spring semester. Three credits.

MA 213 Seminar for Engineers
A review of the mathematics courses taken by the engineering student. A discussion of Laplace Transformations and Fourier Series. Emphasis is on student presentation. This seminar is taken during both semesters of the junior year. Prerequisite: MA 114. One credit.

MA 221 Engineering Drawing
Lettering, use of instruments, applied geometry, sketching, multi-view projection, auxiliary projection, sections and conventions, pictorial drawing, dimensioning, shop drawing and Autocad applications. Enrollment in these courses requires students to purchase the necessary drawing supplies. Offered every other year. Three credits.

MA 223 Mechanics: Statics
Forces in a plane and in space. Equivalent system of forces. Equilibrium of rigid bodies. Centroids and centers of gravity. Moments of inertia. Analysis of structures. Friction. Vectors used extensively. Cross-listed as PH 223. Prerequisite: PH 111 and MA 112. Three credits.

MA 224 Mechanics: Dynamics
Kinematics of particles. Kinetics of particles by: (a) force, mass and acceleration, (b) work and energy, (c) impulse and momentum. Kinematics of rigid bodies. Plane motion of rigid bodies by: (a) forces and accelerations, (b) energy and momentum methods. Mechanical vibrations. Vectors used extensively. Cross-listed as PH 224. Prerequisite: MA 223. Three credits.

MA 350 Independent Study
May be repeated. Variable credit.

MA 550 Cooperative Education — Mathematics Internship
Work experience program extending the learning experience beyond the college into the world of work. Students are employed in an area related to their academic endeavor. Academic credits are P/F and are awarded according to the extent of the work experience. Students may or may not be paid depending on the site. The purpose of the program is to integrate academic studies and employment activities. May be repeated. Variable credit.