Introductory courses in the Division of Mathematics and Natural Sciences help students become familiar with elementary principles which form a basis for understanding of each discipline. Instruction clarifies methods of observation, experiment, analysis, and reasoning by which insight is gained into the nature of the mathematical and physical worlds. Introductory courses and subsequent more intensive courses in mathematics and the natural sciences are planned as part of the students' broad education in the liberal arts. Advanced courses in different scientific fields broaden students' knowledge and also give them training in specialized techniques characteristic of the individual sciences.

An important part of science students' experience at Reed is the thesis, an independent project of research or of critical or creative work carried out under guidance of a member of the staff. For several years mathematics, biology, chemistry, and physics faculty have received grants in support of research and instructional programs. These grants have greatly increased equipment and resources available for senior thesis projects. Qualified seniors may gain valuable experience by assisting in work covered by grants.

By national standards, an unusually high percentage of graduates of this division continue in graduate school the pursuit of their careers in scientific disciplines.

DIVISIONAL REQUIREMENTS

The Division of Mathematics and Natural Sciences maintains no specific requirements. A student in the division must fulfill all requirements for the department in which he or she has been selected as a major as well as all general college requirements.

MATHEMATICS

FACULTY
and professional interests.

HUBERT CHRISTENSEN
Analysis.

THOMAS DENNEHY
Analysis.

JOHN DUEMM
Probability and statistics.

BULWERIS HUNT
Analysis and number theory.

JOHN LEADLEY
Algebra.

V. RAO POTLURI
Finite group theory.

JOE ROBERTS
Number theory and combinatorics.

THOMAS WITTING
Differential geometry and group representation theory.

LLOYD B. WILLIAMS
Analysis.

Mathematics courses present a program of general studies for liberal arts students and also provide a basis in elements of subject for the student who plans to specialize in mathematics or in a field using mathematics.

Mathematics 113 contains a closely reasoned introduction to mathematical thinking, and is followed by an introduction to elementary calculus in Mathematics 122. A course in combinatorial methods may be offered, following Math 113, if there is sufficient demand. Mathematics 122 is usual for science majors.

Course listings represent offerings of recent years. Course offerings are approximately 10% of the recent offerings. Therefore, for a specific topical description, consult the instructor at registration.

COURSE REQUIREMENTS

Optional of work needed to meet general college requirements.

Mathematics 113, 122, and 210, or Math 112. Eight units in mathematics courses in addition two units in analysis and one of physics course. Mathematics 470.

Recommended but not required: one course in a foreign language.
COURSE REQUIREMENTS

Inclusive of work needed to meet general college requirements.

Mathematics 113, 122, and 210, or Mathematics 113, 202 and 203.
Eight units in mathematics courses numbered higher than 300,
including two units in analysis and two in algebra.

One physics course.
Mathematics 470.
Recommended but not required:
one course in a foreign language.

COURSES OFFERED

113/116 INTRODUCTION TO MATHEMATICS

Full course for one semester. A presentation of some of the most central ideas
in mathematics. Concentration is on mapping and algebraic systems. Unifying
thread of the course is construction of the real number system, starting with
one axion about mappings. Prerequisite: none; however, students should have
the equivalent of two years of algebra and one year of geometry.

122/123 INTRODUCTION TO CALCULUS

Full course for one semester. A continuation of 113, using immediately
learnt and
resulted. The course presents the central theory of the calculus of one real
variable: continuity, the intermediate value theorem, properties of a function
continuous on a closed bounded interval, differentiation of elementary
functions, with applications, the mean value theorem, the definite integral,
and the fundamental theorem of calculus. Prerequisite: Mathematics 113.

202 CALCULUS I

Full course for one semester. This course and its sequel, Mathematics 203,
are designed to accommodate those entering freshmen who have had a year's
work in calculus upon entrance. The material included is essentially that of
Mathematics 210, with topics from Mathematics 123 as required. Prerequisite:
Mathematics 113, one year of calculus, and permission of instructor.

203 CALCULUS II

Full course for one semester. Prerequisite: Mathematics 202. Not offered
1975-76.

210 MATHEMATICAL ANALYSIS II

Full course for one year. A continuation of 122, including Taylor's theorem,
finite series, ordinary differential equations, and an introduction to calculus
of functions of several variables. Prerequisite: Mathematics 122.
0 281 PROBABILITY AND STATISTICS

Full course for one semester. An introduction to probability and mathematical statistics. Discrete and continuous probability distributions are studied as models for chance experiments, with particular emphasis on problems of estimation. Prerequisite: Mathematics 12 or 122.

0 301 PROBABILITY AND STATISTICS II

Full course for one semester. Estimation and tests of hypotheses, with particular emphasis upon linear models, regression and analysis of variance. Prerequisite: Mathematics 281. Offered only alternate years beginning 1975-76.

0 302 GENERAL MATHEMATICS

Full course for one year. A terminal course in mathematics for junior and senior science students who have not taken 113. Topics chosen from arithmetic and algebra, number theory, calculus, and analytic geometry. Prerequisite: junior or senior standing or permission of instructor; open only to students with inadequate backgrounds for 113.

0 311 COMPLEX ANALYSIS

Full course for one semester. A study of complex functions: Cauchy's theorem, Taylor's theory, analytic continuation. Prerequisite: Mathematics 210 or 203.

0 312 REAL ANALYSIS

Full course for one semester. A study of Lebesgue integral for functions defined on finite dimensional Euclidean spaces, including Fubini's Theorem, convergence theorems, and, if time permits, the Lp spaces. Prerequisite: Mathematics 210 or 203.

0 331 LINEAR ALGEBRA

Full course for one semester. A brief introduction to field structures, followed by presentation of the algebraic theory of finite dimensional vector spaces. Geometry of linear product spaces is examined in the setting of real and complex fields.

0 332 ELEMENTARY ALGEBRA

Full course for one semester. An elementary treatment of algebraic structures of groups, rings, fields, and/or algebras. The course may touch on a number of these areas but is primarily concerned with only one.

0 341 GEOMETRY

Full course for one semester. A study of geometry without the restriction of Euclidean axioms. Projective and affine geometry are examined synthetically, analytically, and as characterizations of the invariance properties of the geometric groups.

0 351 MATHEMATICAL LOGIC I

Full course for one semester. An examination of relations between Boolean algebra and propositional calculus. First order predicate calculus and first order theories are studied. The Skolem-Lowenheim theorem, Godel's incompleteness theorem, and the completeness and undecidability of the pure predicate calculus of first order are discussed, and, as time permits, proved. Some set theory may be included. Prerequisite: Mathematics 113 or 124 and junior or senior standing, or permission of instructor.

0 411 TOPICS IN ANALYSIS

Full course for one semester. Topics selected from one of Mathematics 113 or 124, or permission of instructor.

0 412 TOPICS IN ANALYSIS II

Full course for one semester. Topics selected from one of Mathematics 113 or 124, or permission of instructor.

0 421 ELEMENTARY NUMBER THEORY

Full course for one semester. A study of divisibility, theory of prime numbers, congruences. Prerequisite: senior standing or permission 1975-76.

0 422 ADVANCED NUMBER THEORY

Full course for one semester. A more detailed study of 421 but which require considerably greater preparation. Example: topics may be drawn from algebraic number theory. Prerequisite: permission of instructor. Not offered 1975-76.

0 431 ALGEBRAIC STRUCTURES

Full course for one semester. A study of rings, fields, modules. Prerequisite: Mathematics 311 or 312.

0 432 TOPICS IN ALGEBRA

Full course for one semester. Topics selected from algebra, Galois theory, algebra, and/or algebra. Prerequisite: Mathematics 331 or 332.

0 452 MATHEMATICS LOGIC II

Full course for one semester. A more detailed course than 351 but which require considerably greater preparation. Example: some set theory may be included. Prerequisite: Mathematics 113 or 122 and junior or senior standing or permission of instructor.

0 470 THESIS

One-half or full course for one year.

0 480 SPECIAL TOPICS

One-half or full course for one semester or on
Prerequisite: junior or senior standing and 45.
31 TOPICS IN ANALYSIS I
Full course for one semester. Topics selected by the instructor. Prerequisite: Mathematics 311 and 312 or permission of instructor.

32 TOPICS IN ANALYSIS II
Full course for one semester. Topics selected by the instructor. Prerequisite: Mathematics 311 and 312, or permission of instructor.

33 ELEMENTARY NUMBER THEORY
Full course for one semester. A study of integers, including topics such as divisibility, theory of prime numbers, congruences, and solutions of equations in integers. Prerequisite: senior standing or permission of instructor. Not offered 1975-76.

34 ADVANCED NUMBER THEORY
Full course for one semester. A more detailed analysis of problems arising in 33 but which require considerably greater mathematical background. For example, topics may be drawn from algebraic or analytic number theory. Prerequisite: permission of instructor. Not offered 1975-76.

35 ALGEBRAIC STRUCTURES
Full course for one semester. A study of topics selected from theory of groups, rings, fields, modules. Prerequisite: Mathematics 331 and 332, or permission of instructor.

36 TOPICS IN ALGEBRA
Full course for one semester. Topics selected by the instructor; for example, associative algebra, Galois theory, algebraic geometry, and geometric algebra. Prerequisite: Mathematics 431, or permission of instructor.

37 MATHEMATICS LOGIC II
Full course for one semester. More detailed analysis of problems of the kind arising in Mathematics 351, but which require greater mathematical background. Topics will be chosen from the following: model theory, algebraic logic, existence of decision procedures, and related questions for first order theories. Conditions under which the consistency of a first order theory can be proved within the theory. Prerequisite: Mathematics 351 or permission of instructor. Not offered 1975-76.

38 THESIS
One-half or full course for one year.

39 SPECIAL TOPICS
One-half or full course for one semester or one year. Independent reading. Prerequisite: junior or senior standing and approval of instructor and division.
PROGRESSION TO THE BACHELOR OF ARTS DEGREE

To be eligible to receive the bachelor of arts degree from Reed College, students must fulfill six basic requirements: sufficient units of academic work; college distribution requirements; major division and/or department distribution requirements; junior qualifying examination; senior thesis; and written oral examination. A description of these requirements follows.

CREDIT REQUIREMENTS

Minimum credit required for graduation following a four or five year program of study is 30 units of academic work plus 1.5 units of physical education. Students of exceptional preparation and ability may be recommended by the faculty for graduation at the end of three years and upon completion of 27 units of academic work plus 1.5 units of physical education. (For a definition of the unit measurement and other specifics, see the paragraph headed Course Load.)

To be eligible for graduation, students completing work in three or four years must carry six academic units of work in their degree year; at least two academic units—one of which must be in a non-thesis course—must be carried in any semester. The six units, however arranged, constitute a full program for the academic year and require payment of full tuition each semester. The work of the degree year is to be done while attending Reed, except in pre-engineering, pre-veterinary, pre-medical study, the Reed-Portland Museum Art School program, and when students' educational interests can be better served through other special arrangements.

COLLEGE DISTRIBUTION REQUIREMENTS

The course distribution required of all Reed undergraduates is carefully designed and frequently re-evaluated to assure a broad understanding of the arts and sciences, which a liberal education signifies.

Humanities
Humanities 120, 130, or 140 is required of all freshmen. It may be required of transfer students if they lack background in this area.

Group A Literature, Philosophy, and the Arts
Minimum of one full-year course or the equivalent in semester courses totaling two units, which may be selected from the following: art (excluding studio courses), Humanities 210, music (excluding applied music courses), Philosophy 210, Religion 210, or Theatre 210, or advanced subject matter courses in any of these fields, or in English and foreign literature courses of 310 or higher.

Group B History and the Social Sciences
Minimum of two units in the same department from: Anthropology 211, and one additional advanced approved anthropology course, Economics 210, Humanities 210, Political Science 210, Sociology 201/202 or 210, or any two units in history.

Group C Mathematics and the Natural Sciences
Minimum of four units, only two of which may be in mathematics, chosen from any offering in biology, chemistry, mathematics, physics, Natural Science 110, or Psychology 220. Students may not use more than two units in their major field of study to satisfy the Group C requirement.

Proficiency in a foreign language as a requirement for graduation is a matter left to the discretion of the major departments or divisions. Some retain a language requirement, and most of those who do not require foreign language study do recommend that whenever possible such study should be included in the student's program.

ACCEPTANCE AS A MAJOR

Students applying for acceptance as a major are evaluated by the division, department, or interdisciplinary committee at or near the end of the sophomore year. Students are advised of the faculty's current opinion of their prospects as a major. After acceptance, students carefully plan, in consultation with their advisors, a tentative schedule for their entire upperclass program. Specific course and credit distribution requirements for majors are detailed in descriptions of divisions, departments, and interdisciplinary programs.

QUALIFYING I

Students pass a qualifying examination in their major division and/or department beginning in the junior year at the end of the junior year, at the end of the junior year. It is possible that a student's proficiency in a field may be reviewed. In some cases, it may be possible for students to transfer to a review may also identify this work to develop their capabilities in the work of the senior thesis.

The qualifying examination, best students and in actual student's performance in the previous course work is divided into three meetings to assess work on a thesis.
FRIBUTION

As of all Reed undergraduates are re-evaluated to assure a
suitable and science, which a liberal

required of all freshmen. It may be

in the arts

and the arts

one may be chosen from the
courses, Philosophy 210,

Sciences

within the department from:
advanced subject matter

Natural Sciences

of which may be in
offering in biology, chemistry,

Science 110, or Psychology 220,
two units on their major field

as a requirement for
discipline of the major

as a language requirement,
 required foreign language study

I A MAJOR

as a major are evaluated by
disciplinary committee at or

Students are advised of
their prospects as a major.
their entire upperclass

It distribution requirements

QUALIFYING EXAMINATION

Students pass the qualifying examination administered by the
major division and/or department before being allowed to
begin a thesis in the senior year. The examinations, given near
the end of the junior year, are intended to test general
preparation, grasp of major subjects, and capacity for
independent work, which a satisfactory thesis requires.
It is possible that a student who does not demonstrate
competence in an area may be required to take further work.
In some cases, it may be possible that a student may be
couraged to transfer to another department or division. The
review may also identify those who appear to need more time
to develop their capabilities for the sustained independent
work of the senior thesis.

The qualifying examination is not meant to qualify only the
best students and in actuality does not operate that way. The
student's performance in the examination as well as in all
previous course work is discussed in full departmental or
divisional meetings to assess the student's readiness to begin
work on a thesis.

THESIS

As part of the requirements for graduation, students must
prepare an acceptable thesis upon a particular phase of their
major. A thesis project must be approved by the major division,
department, or interdisciplinary committee. It must be an
integral part of the student's educational program and
demonstrate powers of organization, general grasp of the
field, and capacity for independent work and thought. Reed
theses, averaging approximately one hundred pages, are
bound and cataloged in the college library. Some have been
of such quality that they have been published in scholarly
journals.

The senior thesis is viewed as the capstone of the Reed
education, providing an opportunity for sustained and
developmental examination of a significant problem in the
student's field of major study.

ORAL EXAMINATION

The candidate for graduation takes a final comprehensive
two-hour oral review under the direction of the major division
or department. The oral examination may cover the work of the
student's entire program, but emphasis is on the thesis and
major field. The committee of examiners will include faculty
from the student's own department and division, a second
division and, on occasion, professionals from outside
the college.
The curriculum of undergraduate courses makes the process of achieving an education at Reed a stimulating and absorbing experience to be fully explored and valued.

The Reed undergraduate education combines broad understanding of arts and sciences with a comprehensive grasp of at least one academic discipline. Ensuring breadth are two aspects of the Reed undergraduate curriculum: first, the humanities program and second, distribution of courses.

Humanities courses at Reed examine selected landmarks in the political, philosophical, and artistic development of Western civilization. The approach is interdisciplinary; the subject matter derives from a variety of humanistic disciplines.

A course in humanities is the first of four distribution requirements fulfilled by Reed students to earn the bachelor of arts degree. In addition, the college requires a minimum of two units in literature, philosophy, religion or the arts (Group A); two units in history or the social sciences (Group B); and four units in mathematics and the natural sciences (Group C). Specifics of these requirements as well as an explanation of the unit measurement may be found in the section later in the catalog entitled Academic Policies.

In working toward the bachelor of arts degree, Reed students generally select and complete 30 units of academic work plus 1.5 units of physical education in four years, although students may, in special circumstances, complete the program in three years with 27 units of academic work.

Students should, whenever possible, complete the general college requirements within their first two years, so that they may focus much of their upperclass work on special fields of interest. At the same time, they should assure themselves of the necessary preparation for later courses within, or related to, their contemplated majors. In addition they must meet certain requirements of the division, department or both.

Typically students begin concentration in one particular field at the close of the sophomore year, when they are accepted as majors into a department and into the division to which that department belongs.
In their junior year, Reed students are reviewed to assure their comprehension of their chosen fields before beginning the senior year which includes preparation for a senior thesis. The thesis is one of the most important aspects of the Reed education and gives Reed students the opportunity to prepare a comprehensive work in their selected fields of interest. Each senior thesis is bound and catalogued for future use in the college library and is sometimes of such quality as to be published in scholarly journals. At the end of the academic year, seniors individually debate and defend their theses with faculty and professionals in the field.

A Reed student may select as a major field one of the following areas:

<table>
<thead>
<tr>
<th>Department</th>
<th>Major Field</th>
<th>Major Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropology</td>
<td>French Literature</td>
<td>Physics</td>
</tr>
<tr>
<td>Art</td>
<td>General Literature</td>
<td>Political Sciences</td>
</tr>
<tr>
<td>Biology</td>
<td>History</td>
<td>Religion</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Mathematics</td>
<td>Russian Literature</td>
</tr>
<tr>
<td>Classics</td>
<td>Music</td>
<td>Sociology</td>
</tr>
<tr>
<td>Economics</td>
<td>Philhosophy</td>
<td>Theatre</td>
</tr>
</tbody>
</table>

In addition, interdisciplinary majors are available in:

<table>
<thead>
<tr>
<th>Department</th>
<th>Major Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Studies</td>
<td>Literature-Philosophy</td>
</tr>
<tr>
<td>Chemistry-Physics</td>
<td>Literature-Theatre</td>
</tr>
<tr>
<td>Dance-Theatre</td>
<td>Mathematics-Economics</td>
</tr>
<tr>
<td>History-Literature</td>
<td>Mathematics-Physics</td>
</tr>
<tr>
<td>History-Russian</td>
<td>Mathematics-Sociology</td>
</tr>
<tr>
<td>International Studies</td>
<td>Philosophy-Religion</td>
</tr>
</tbody>
</table>

To supplement these established interdisciplinary majors, special programs that temporarily link two or more disciplines can be approved if, in the faculty's judgment, a proposed program is a carefully reasoned alternative to an established major field of study and if the student is believed capable of integrating the constituent disciplines.

In pursuing his or her studies, the Reed student has the opportunity to examine an exciting number of fields. A summary of the specific courses available to the Reed undergraduate follows.