COLLEGE OF LIBERAL ARTS & SCIENCES

THE UNIVERSITY OF IOWA

Department of Mathematics

Handbook for Undergraduate Majors

14 MLH (MacLean Hall)
Iowa City, IA 52242

(319) 335-0714

http://www.math.uiowa.edu

(D. Randell, 1989)
(J. Simon, January 1999)
(D. Anderson, November 2004)
(W. Han, August 2007)
(D. Stewart, November 2007)

DEPARTMENT OF MATHEMATICS
HANDBOOK FOR UNDERGRADUATE MAJORS

A successful math major represents a special combination of creativity and analytic rigor that is respected worldwide. Those of us who "do" mathematics are constantly excited by the combination of internal beauty and powerful applicability that motivate our studies. It's simply great stuff---challenging, fun, and vitally important to society.

Mathematics is a basic tool for understanding the world, and it is a crucial requirement for many careers in science, engineering, business and the professions. It is also a living, dynamic field of research.

There are several paths to a mathematics degree, so the lists of options may look confusing; just remember, for most tracks, ***you need eleven (11) courses for a BA, thirteen (13) for a BS***. A minimum g.p.a. of 2.0 in the major is required to obtain a degree in mathematics, but you should aim much higher.

There are three tracks in the major: PROGRAM A (for students who plan to work in industry or government or to pursue graduate study in mathematics), PROGRAM B (Mathematics Education), and PROGRAM C (mathematics with specialization in a math-related area).

Each track in the major has a core of several courses, followed by choices for electives. All the PROGRAMS begin with 2 semesters of calculus and a course in linear algebra; your high school background and AP or other college level work will influence where you start. The next level of core courses includes 2-4 courses (depending on the track) in multivariable calculus, introductory analysis, introductory abstract algebra, and differential equations. After the core courses, you select electives from upper level mathematics courses as well as certain courses in statistics/actuarial science or computer science (see also PROGRAM C).

We encourage you to pursue interests in the many fields where mathematics is important, such as business and the physical or social sciences. If you want to enter the job market with a BA/BS degree, you should include courses in Computer Science, Statistics, and some area(s) of application. PROGRAM C allows you to develop a strong area of application and is especially suited to double majors.

There is a special track, PROGRAM B, for students seeking certification for secondary teaching. For certification you will need to meet a combination of mathematics requirements and College of Education requirements.

While mathematics is not the most common route to careers in fields such as Law or Medicine, we should note that such professional schools, along with graduate programs in many other fields, do welcome math majors. The key is to also take courses in those areas to demonstrate your interest and breadth of ability.

Graduate study is the expected route for college or university teaching and research, and it is advisable for certain industrial and governmental positions.

In this handbook we discuss how to set up programs of study appropriate to your goals and offer some tips and useful information about scheduling, preparation for jobs or graduate school, special opportunities for research, scholarships, etc.

The Department of Mathematics is part of the College of Liberal Arts and Sciences (CLAS), so mathematics majors need to meet CLAS requirements as spelled out in the University Catalog. This *Handbook* is available in the Mathematics Department office and on the internet at *http://www.math.uiowa.edu.* The web site also has additional Department information as well as the home pages of many of the faculty and other students.

Contents

NOTE: Please forward suggestions for improving this *Handbook* to Prof. David Stewart, 325B MLH, 335-3832, dstewart@math.uiowa.edu. During the year, there may be corrections or policy changes, so students and advisors should check occasionally for updates.

DEPARTMENT ADMINISTRATION AND ADVISING

The Mathematics Department has a Chair (Prof. Yi Li) and two Associate Chairs (Prof. Dan Anderson, Director of the Graduate Program and Prof. David Stewart, Director of the Undergraduate Program). The faculty elects its Undergraduate Committee (likewise a Graduate Committee). In 2006-2007, Professors Stewart (Chair), Durumeric, Gatica, Jay, Seaman, Bleher, and Roseman serve on the committee. Day to day decisions implementing Department policies are made by the Program Directors or at the Committee level. The Committees make policy recommendations to the Department faculty.

We have an excellent support staff, including certain Secretaries who deal often with students: Margaret Driscol handles money matters and also is the person to see about meeting with the Department Chair. Cindy Van Ark works most closely with the Graduate Program. Katie Voss works closely with the Undergraduate Program.

Students in all majors usually receive initial advising from AAC, the Academic Advising Center in Pomerantz Center. From the second year on (maybe sooner for some students), each student is assigned a faculty advisor in the Department of Mathematics. Most students are assigned first to the Director of the Undergraduate Program to provide extra uniformity; after one or two semesters, other faculty take over. For students in the Teacher Education Program (TEP), there also will be a TEP advisor.

PEOPLE TO CONTACT	PHONE AND/OR EMAIL
Prof. David Stewart Director of Undergraduate Program	325B MLH, 335-3832 dstewart@math.uiowa.edu
Katie Voss, Secretary	14 MLH, 335-3175 kvoss@math.uiowa.edu
Cos Fi, Mathematics Education Program Coordinator Or contact TEP Applications	N256 LC, 335-6440 cos-fi@uiowa.edu
TEP Applications	N310 LC, 335-5359
Academic Advising Center	C210 Pomerantz Center, 335-5700
Prof. David Stewart Department Honors Advisor	325B MLH, 335-3832 dstewart@math.uiowa.edu

OVERVIEW OF THE BA/BS PROGRAMS

There are three PROGRAMS leading to a BA or BS = (BA plus two extra upper level courses). These are summarized below. See **DETAILS OF PROGRAM A, ...B, ...C** for more information.

In addition, the Department offers a minor. It is especially easy to do a double major, or major/minor combination in Mathematics, with Statistics/Actuarial Science or with Computer Science because of the number of their courses that count towards a Mathematics degree. (See section on **Double Majors**)

- PROGRAM A is the traditional and most general degree. This PROGRAM is extremely flexible. One student might take electives specifically preparing for graduate work in math, while another might take courses emphasizing tools for applications, including 22C: (Computer Science) and 22S: (Statistics and Actuarial Science) electives.
- PROGRAM B serves the math majors who are preparing for secondary school teaching. This is a carefully designed program enabling students to satisfy the State of Iowa requirements for Secondary Teaching Certification, as well as College of Education and Department of Mathematics requirements. After completing at least 40 semester hours of college credit, including two semesters of calculus (and with satisfactory GPA), a student applies for admission to the Teacher Education Program in the College of Education. The student continues to be advised jointly by Mathematics and Education faculty. In addition to mathematics courses, TEP students take specified courses in Education and can select liberal arts GE courses to meet other State requirements. However, a student may pursue PROGRAM B without being admitted to the TEP.
- PROGRAM C is designed for students who want a degree in mathematics with a clear specialization in some area of application. The key is that certain courses in the area of application are counted towards the Mathematics degree. (This also facilitates double majors or major/minor combinations.) Students can focus on areas for which templates already have been designed (Optimal Business Decision Making, Economics, Physics, Biomathematics, Biostatistics, Chemistry, Computer Science, Statistics/Actuarial Science) *or propose new ones*. In consultation with a Mathematics faculty advisor, the student prepares a program of studies tailor-made to her/his future plans or career needs. The proposed program of studies must be approved by the Director of the Undergraduate Program and the Mathematics Department Undergraduate Committee.

PLANNING YOUR PROGRAM

This section has general advice and several sample schedules. Remember the samples are just samples, not rigid specifications. For PROGRAMS A, B, and C we list the specific requirements you need to satisfy. These are quite flexible, so we do not expect you to need to ask for substitutions or other modifications. But you do have that right, and may appeal to the Department (via the Director of the Undergraduate Program) if you wish to propose a modification. You should consult closely with your faculty advisor before making such an appeal.

Because of the special nature of PROGRAM C, it is essential that you work with your Mathematics faculty advisor as early as possible in planning your multi-year schedule in that PROGRAM.

It is not hard to get a second major. Natural tie-ins include Computer Science, Statistics or Actuarial Science, since many courses can be counted toward both majors. Other nice combinations are with Physics, other physical or biological sciences, Economics, and other social sciences. Some students also pursue Math/Music and Math/Philosophy combinations. If you are planning a double-major in an area where mathematics is used a lot, PROGRAM C might be appropriate.

PLANNING THE FIRST YEAR

You need to complete certain courses as soon as possible in order to progress through the degree in a timely way, and, in particular, to access upper level courses with various prerequisites. The section **PREREQUISITE STRUCTURE FOR CORE COURSES** will help you navigate.

To complete at least 11 courses [13 for BS] in four years, you need to carry at least two courses in several semesters. You may want to "start easy", but you should expect to carry two Math (or applicable CS, Stats) courses most terms. On the other hand, don't overload with mathematics and ignore the rest of human life and culture.

Notice the key roles of the seven core courses. Each of these courses is offered Fall and Spring every year (except M56 = spring); also 25-26-27 and 100 often are offered in the Summer.

- Calculus I and II (there are several "flavors" of Calc I-II to choose from; see later section on **CALCULUS COURSES**) [PROGRAMS A,B,C]
- Linear Algebra (M27) [PROGRAMS A,B,C]
- Intro. Abstract Algebra I(M50) [PROGRAMS A,B, some C]
- Spaces and Functions I (M55) [PROGRAMS A,B, some C]
- Multivariable Calculus (M28) or Spaces and Functions II (M56) [M56 for PROGRAM A, M28 or M56 for PROGRAM B, M28 or M56 for PROGRAM C]
- Intro. Differential Equations (M100) [PROGRAMS A, some C]

First complete one of the Calculus I-II sequences, and Linear Algebra. This can be done in two semesters by doubling Calc II + M27 in the second semester. After Calc I-II and M27, advice depends on whether you are in PROGRAM A, B, or C. If you are developing another area (e.g. Education, a Program C focus, a minor, etc.), plan your schedule to cover that area's prerequisite structure as well.

MATHEMATICS INCENTIVE PROGRAM (MIP)

If you studied Calculus in high school or elsewhere, but did not receive AP credit, or transfer credit, or any other college credit for Calculus I, we want you to be able to start here with Calculus II rather than repeating Calculus I. That's why the MIP was invented. If you place into Calculus II and receive a grade of at least "B" in the course, then you automatically will receive 4 s.h. credits for Calculus I in addition to the credit you earn for Calculus II.

PLANNING THE SECOND YEAR AND BEYOND

For PROGRAM A, take M55-56 your second year, doubling M50 with either of those, and M100 after M56. If you postponed M27 to the second year, you can take M55 at the same time, and take M50 + M56 the following semester. (M27 is a prerequisite for M50 and a co requisite for M55. (Incidentally, the word co requisite means the course may be taken before or together with the other one). You can take M100 in the third year along with beginning your upper level electives.

If you are hoping to go to graduate school for a Ph.D. in Mathematics, you should try to take at least one or two of the upper level courses (such as M115, 116, 120, 121, 123, 124, 130, 132, 133, 140, 142, 144, 160, 161, 170, 171) in your third year so grades and recommendations can include these courses when you apply to graduate school in fall of year 4. Solid preparation for a Ph.D. program would be a BS under PROGRAM A including 22M:115-116 and 22M:120-121.

If you are aiming for work in industry/government after the BA/BS, or after an MS degree, or a Ph.D. program specifically in "applied mathematics", then you should emphasize courses on differential equations, numerical analysis, modeling, and Computer Science/Statistics.

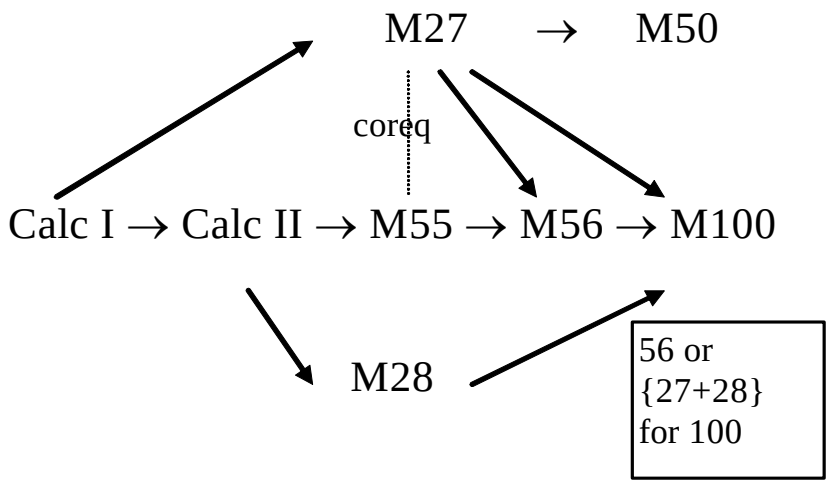
In either case, view the 11 [13 for the BS] course requirement as minimal, and try to go beyond that.

As is common in many universities, several of our upper level undergraduate courses also are the courses on which the MS degree is based; so these are the courses on which an application to a Ph.D. program might be based. Here at Iowa, we offer MS Comprehensive Exams: M115-116, M120-121, M132-133, M142 and M144, and M170-171.

For PROGRAM B (and Teaching Certification), your schedule will be quite full. In particular, one semester during your fourth year will be filled with student teaching. Thus, it may be difficult to go mathematically beyond the already substantial basic degree requirements without careful planning. Because of the specific requirements of PROGRAM B (both Mathematics and Education courses), it is easier to switch from PROGRAM B to PROGRAM A than to go the other way. To finish this program in four years, you must be ready to start the TEP courses no later than the start of your third year.

For PROGRAM C, you should work out your multi-year plan very early, ideally by the end of your first year. Remember the plan needs to be approved by your advisor, and then by the Director of the Undergraduate Program or the Mathematics Department Undergraduate Committee. In addition to planning your math courses, you need to make a plan to work through the appropriate courses in your area of application, where there may also be prerequisites. You should finish Calculus I-II, M27, one of {M28 or M56}, and one of {M50, M55} by the end of the second year.

PREREQUISITE STRUCTURE FOR CORE COURSES



A grade of B or better in both 22M:27 and 22M:55 is required for 22M:56. Students should take 22M:28 (PROGRAMS B,C) or else 22M:56 (PROGRAMS A, B, C), and cannot receive credit for both.

Minimum course requirements for a BA are:

Program A Required: Calc I-II, 27, 50, 55-56,100, +electives.

Program B Required: Calc I-II, 27, 28, 50, 55, 70, {150 or 151}, C16, S120, +elective.

Program C Required: Calc I-II, 27, {28 or 56}, {50 or 55}, +others required or elective.

For the BS, two additional upper-level courses must be completed in any program.

WHEN ARE VARIOUS COURSES OFFERED?

The timing and frequency for various courses is not rigidly fixed. Here is the recent pattern.

Each Fall and Spring: Calc I, Calc II, 27, 28, 50, 55, 72, 100

Each Fall: 115, 118, 120, 126, 132, 142, 150, 160, 170

Each Spring: 56, 70, 95, 96, 116, 121, 127, 133, 144, 151, 161, 171, 174

Every other year: 123 (Fall), 124 (Spring), 140 (Fall), 152 (Spring)

Offered occasionally: 107, 108, 178

Each summer: 25, 26, 27, 100, 107, 127

Through Guided Independent Study: 25, 26, 27, 50, 107

DETAILS OF PROGRAM A: Mathematics (BA or BS)
This program requires 7 core courses plus a minimum of 4 (BA) or 6 (BS) electives.

Core Courses

Calculus I and Calculus II 8 s.h.

> Any of the sequences 22M:25-26, 22M:31-32 is acceptable. The sequences are distinct enough that the Department does not encourage students to switch from one version of Calc I to a different version of Calc II unless there is a strong need and good preparation. Advanced placement credit, CLEP credit, and credit obtained through the Mathematics Incentive Program is accepted for all or part of the calculus requirement.

22M:27 Introduction to Linear Algebra 4 s.h.

22M:50 Introduction to Abstract Algebra I 3 s.h.

22M:55-56 Fundamental Properties of Spaces and Functions I-II 7 s.h.

22M:100 Introduction to Ordinary Differential Equations 3 s.h.

Higher level courses may be substituted for core courses if approved by the Department.

Electives

For the BA degree, students must take at least four elective courses (each 3-4 s.h.) from the following list, including at least one *upper level Mathematics* course (see list below); for the BS degree, the requirement is six elective courses from the list, including at least three that are *upper level Mathematics* courses.

Eligible electives
Mathematics courses 22M:70 or higher (excluding 22M:81, 22M:104, 22M:105, 22M:109, and 22M:195).

Computer Science courses 22C:16 or higher that count towards an undergraduate major in Computer Science (excluding 22C:19(old 22C:34), 22C:197, 22C:198).

Statistics and Actuarial Science courses 22S:39, 120, 130, 131, 138, 150, 153, 154, 156, 158, 174, 175, 176, 180, 181, 182, 193, 194, 195, 196. (At most one of 22S:39, 22S:120 and 22S:130 can be counted; 22S: 39, 22S:120 or 22S:130 cannot be used if taken after 22S:153.)

Upper Level Mathematics courses are 22M:96, 22M:115 or higher (excluding all 22M:195-199).

DETAILS OF PROGRAM B: Mathematics for Secondary-School Teaching

This program is intended for students seeking secondary school teaching licensure. However, students not seeking licensure may complete the program. They are then not required to be admitted to TEP. To obtain licensure, students complete Mathematics BA/BS requirements and also certification requirements of the State and the College of Education, through the Teacher Education Program (TEP) in the College of Education. The information presented here is sufficient for most planning, but students also need to obtain a licensure program guide and a TEP application form from the Office of Teacher Education and Student Services, N310 Lindquist Center. The education courses serve as electives in the Mathematics degree.

The PRAXIS I exam is required for admission to TEP. PRAXIS II is currently required for licensure. See a TEP advisor, the Office of Teacher Education and Student Service (N310 LC), or go to www.education.uiowa.edu/tess for additional information.

There are three sets of requirements for secondary-school certification in mathematics:
1. Admission to the TEP. See www.education.uiowa.edu/tess.
2. Mathematics (including some 22C and 22S) courses for BA/BS degree.
3. College of Education courses.

1. Admission to the TEP

Students apply to the TEP after completing at least 40 s.h. of college work, including Calculus I and II. To be considered, a student needs a cumulative g.p.a. of 2.7 on all course work and on all course work at the University of Iowa, and a minimum g.p.a. of 2.5 in the Calculus courses. In addition, students should have completed a 10 hr. volunteer practicum in a secondary-school setting (though one might be admitted to the TEP conditionally and do the practicum during that semester). A limited number of applicants are accepted into the mathematics teacher education program, so meeting the minimum does not ensure admission. Other criteria relevant to teaching success are also considered. A student in the TEP has a TEP advisor as well as a Mathematics advisor. The student should meet with both advisors to plan and monitor progress. See www.education.uiowa.edu/tess for more information.

2. Mathematics Courses (11 for BA, 13 for BS)

Calculus I and Calculus II		8 s.h.
22M:27	Introduction to Linear Algebra	4 s.h.
22M:28	Calculus III	4 s.h.
22M:50	Introduction to Abstract Algebra I	3 s.h.
22M:55	Fundamental Properties of Spaces and Functions I	3 s.h.
22M:70	Foundations of Geometry	3 s.h.
22M:150	Introduction to Discrete Mathematics	3 s.h.
or		
22M:151	Discrete Mathematical Models	3 s.h.

Continued on page 8.

One additional Mathematics course beyond calculus		3 s.h.
22C:16	Computer Science I	4 s.h.
22S:120	Probability and Statistics	4 s.h.

Candidates for the BS degree must take at least three additional math courses (instead of one for BA) beyond calculus, of which two must be numbered 22M:106 or higher. (BS level CS or Stats courses might be acceptable - submit proposal.)

While the additional course(s) for the BA/BS can be any post-calculus courses, the following might be especially useful: (a) whichever of 22M:150 or 22M:151 was not used to satisfy the first list; (b) any of 22M:107, 108, 126.

3. College of Education Courses (each is 3 s.h. unless indicated otherwise)

This course can be taken before admission to the TEP

7P:075 Educational Psychology and Measurement

These can be taken only by students who have been accepted in the TEP.

Mathematics Education

7S:095 Introduction and Practicum: Mathematics
7S:134 Curriculum and Methods: Middle School Mathematics
7S:135 Curriculum and Methods: High School Mathematics

Professional Education

7S:100 Foundations of Education
7B:180 Human Relations for the Classroom Teacher
7S:195 Teaching Reading in Secondary Content Areas (1 s.h.) (required for students admitted March 2003 or later)
7S:190 Orientation to Secondary Education (1 s.h.) (required for students admitted March 2002 or later)
7U:100 Foundation of Special Education
7E/S:102 Technology in the Classroom

These three comprise **Student Teaching**, your final semester.

7S:187 Seminar: Curriculum and Student Teaching (1 s.h.)
7S:191 Observation and Laboratory Practice in the Secondary School (6 s.h.)
7S:192 Observation and Laboratory Practice in the Secondary School (6 s.h.)

Order of education courses does matter. 7S:190, 7S:195 and 7E/S:102 must be taken during the first semester in the College of Education. It is also recommended that 7P:75 and 7S:95 be taken as soon as possible. Check with the College of Education for details. A checklist of the required math and education courses may be found at the College of Education website (http://www.education.uiowa.edu/tess/tep/certguidesinfosec.html).
Note that 7B:180 also counts towards the CLAS Cultural Diversity/Distributed Education GE requirement.

DETAILS OF PROGRAM C: Mathematics + Area of Application

In consultation with her/his Mathematics faculty advisor, the student prepares a proposed list of courses. The plan (with advisor's endorsement) is then forwarded to the Department's Director of Undergraduate Studies for approval. If the proposal closely follows one of the templates below, then approval is likely to be automatic. Otherwise the proposed program of studies still must receive approval of the Mathematics Department Undergraduate Committee. A standardized form can be obtained from the departmental office or online at www.math.uiowa.edu/Undergrad/ProgramCform.pdf

Core Courses

Calculus I and Calculus II 8 s.h.

(As noted earlier, we have several alternate sequences. They are distinct enough that we do not encourage you to switch from one version of Calc I to another version of Calc II unless you are doing quite well. Advanced placement credit, CLEP credit, and credit obtained through the Mathematics Incentive Program is accepted for all or part of the calculus requirement.)

22M:27	Introduction to Linear Algebra	4 s.h.
or		
22M:47	Linear Algebra and Differential Equations (for certain areas of applications)	3 s.h.

22M:28	Calculus III	
or		4 s.h.
22M:56	Fundamental Properties of Spaces and Functions II	
or		
22M:48	Vector Calculus for Scientists (for certain areas of application)	3 s.h.

One additional course emphasizing proofs (e.g., 22M:50, 55) 3 s.h.

Some programs have additional core courses, and the student should examine carefully the core courses required for his or her program.

Electives

Usually six (6) courses for the BA degree, eight (8) courses for the BS degree, selected according to area of specialization. **However, at least three of the courses must be in mathematical sciences (Math., CS, Stats.).**

If an area specifies additional core courses, these are counted towards the electives, so the total number of courses required remains 11(BA) or 13(BS). Also, if any of these additional core courses are in the mathematical sciences, they are counted toward the three required courses. Because of prerequisite structure in the area of application, we realize some students might need extra courses in order to take the 11 (or 13).

Templates for PROGRAM C

Biomathematics

Department of Mathematics (Program C) BA/BS subtrack: Biomathematics	**This program requires 7 core courses plus a minimum of 4(BA) or 6(BS) electives. The core courses are in Mathematics; the electives are taken in Mathematics and in Biomathematics.**
Core Courses	*For any of the core courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:55 Fund Props Spaces & Functs I (4 s.h.)	
22M:100 Intro to Differential Equations (3 s.h.)	
22M:140 Continuous Math Models (3 s.h.)	
List of Electives	(4 for BA, 6 for BS) Select 1 or more from Group I, 2 or more from Group II, & all from Groups I, II, & III.
Group I (one or more)	22M:72 (Elementary Numerical Analysis), 22S:120 (Probability and Statistics)
Group II	At least 2 100-level courses in one area of biology such as ecology and evolutionary biology, genetics, molecular and cellular biology, developmental biology, physiology, pharmacokinetics, neurobiology, immunology, biochemistry, epidemiology, microbiology, or biomedical engineering.
Group III	22M:142 (Nonlinear Dynamics w/ Numerical Methods), 22M:144 (Partial Differential Eqs w/ Numerical Methods), 22M:170 (Numerical Analysis: Nonlinear Equations, Approximation Theory), 22M:171 (Numerical Analysis: Differential Equations, Linear Algebra), 22M:174 (Optimization Techniques), 22M:151 (Discrete Mathematical Models), 22C:16 (Computer Science I), any 100-level course(s) in any area(s) of biology

Mathematics and Biostatistics

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics and Biostatistics**	**This program requires 7 core courses plus a minimum of 4(BA) or 6(BS) electives. The core courses are in Mathematics and Biology; the electives are taken in Mathematics, Statistics, and in the College of Public Health.**
Core Courses	*For any of the core courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:55 Fund Props of Spaces & Functions I (3 s.h.)	
22M:100 Intro to Diff Equations (3 s.h.)	
Core Natural Science Requirement	2:002 Introductory Animal Biology
List of Electives (4 for BA, 6 for BS)	(At least 2 from Math., CS, or Stats, & subject to the following requirement) Select 2 or more from Group I, & all from Groups I and II.
Group I (select two or more)	**Group II**
22M:72 (Elementary Numerical Analysis)	22M:170 (Numerical Analysis: Nonlinear Eq Approx Th)
22M:140 (Continuous Mathematical Models)	22M:171 (Numerical Analysis: Diff Eq Linear Algebra)
171:201 (Biostatistical Methods I)	22M:174 (Optimization Techniques)
173:140 (Epidemiology I: Principles)	22M:151 (Discrete Mathematical Models)
175:197 (Environmental Health)	22S:153-54 (Mathematical Statistics I, II)
	171:163 (Intro to Design Sample Surveys)
	171:280 **or** 175:280 (Preceptorship)
These electives must be chosen to include two courses from one of these 3 sequences:	22M:72, 170, 171, 174 (2 electives) 22M:100, 140 (1 core, 1 elective) 22S:153, 154 (2 electives)
and at least one course from the college of Public Health.	

Mathematics and Chemistry

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics + Chemistry**	**This program requires 5 core courses plus a minimum of 6(BA) or 8(BS) electives. The core courses are in Mathematics; the electives are taken in Mathematics and in Chemistry.**
Core Courses	*For any of the core courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26 or 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.) **or** 22M:47 Linear Algebra and Differential Equations for Scientists (3 s.h.)	
22M:28 Calculus III **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:50 **or** 22M:55 (3 s.h.)	
List of Electives	(6 for BA, 8 for BS) (at least 2 from Math, select 4 or more from Chemistry.)
Mathematics 22M: (at least two)	22M:50, 55, 72, 96, 100, or any course numbered 22M:115 or higher, excluding 22M:195-199.
Chemistry 4: (at least four)	4:21 Basic Measurement
	4:111, 112 (Analytical Chemistry I & II)
	4:131, 132 (Physical Chemistry I & II)
	4:143 (Analytical Measurements)
	4:144 (Physical Measurements)
	4:162 Undergraduate Research (with approval)

Mathematics and Computer Science

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics + Computer Science**	**This program requires 5 core courses plus a minimum of 6(BA) or 8(BS) electives. The core courses are in Mathematics; the electives are taken in Mathematics and in Computer Science.**
Core Courses	*For any of the core courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.) **or** 22M:47 Linear Algebra and Differential Equations for Scientists (3 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:50 **or** 22M:55 (3 s.h.)	
List of Electives	Students must take at least six elective courses (each 3-4 s.h.) for the BA [at least eight for the BS] from the following list. The electives must include at least **two** from Mathematics and at least **four** from Computer Science.
Mathematics 22M: (at least two)	22M:50, 55, 72, 100, or any course numbered 22M:115 or higher, excluding 22M:195-199.
Computer Science 22C: (at least four)	22C:16 and any higher number 22C: courses that can be counted in that department towards an undergraduate major in Computer Science.

Note: It is very easy to get the double major a BS in Computer Science and a BS in Mathematics (PROGRAM C Mathematics + Computer Science). You must take Multivariable Calculus (22M:28 or 22M:56) and one proof course (22M:50 or 22M:55) and two additional Mathematics (22M) courses. Note that these two additional Mathematics courses could be 22C:72(22M:72) used to fulfill the Math Elective #2 course requirement and one of the advanced technical electives required for the CS BS: 22C:137/22M:152, 22C:170/22M:170, 22C:171/22M:171, 22C:174/22M:174, and 22C:177/22M:/178.

Mathematics and Economics

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics and Economics**	**This program requires 9 core courses plus a minimum of 2(BA) or 4(BS) electives. The core courses are in Mathematics, Computer Science, Economics, and Statistics; the electives are taken in Mathematics and in Economics.**
Core Courses	*For any of the core Math courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:50 **or** 22M:55 (3 s.h.)	Preferred "proofs" course: 22M:55
22C:16 Computer Science I (4 s.h.)	
6E:104 Microeconomic Theory (3 s.h.)	
6E:105 Macroeconomics (3 s.h.)	
22S:120 Probability and Statistics (4 s.h.)	
List of Electives	(2 for BA, 4 for BS) Select from Group I and Group II.
Group I (one for BA, two for BS)	**Group II** (one for BA, two for BS)
22M:72 (Elem Numerical Analysis)	6E:184 (Intro to Econometrics)
22M:100 (Intro to Differential Equations)	6E:187 (Intro to Math Economics)
22M:115, 116 (Intro. to Analysis I, II)	6E:190 (Economic Analysis I)
22M:130 (Elementary Topology)	6E:191 (Economic Analysis II)
22M:140 (Continuous Mathematical Models)	6E:204 (Macroeconomics I)
22M:151 (Discrete Math Models)	6F:100 (Introductory Financial Management)
22M:152 (Theory of Graphs)	6F:111 (Investments Management)
22M:174 (Optimization Techniques)	6K:176 (Managerial Decision Models)
22C or 22S more advanced than core courses	

Mathematics of Optimal Business Decision Making

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics of Optimal Business Decision Making**	**This program requires 9 core courses plus a minimum of 2(BA) or 4(BS) electives. The core courses are in Mathematics, Computer Science, Statistics, and Business; the electives are taken in Mathematics and in Mathematics of Optimal Business Decision Making.**
Core Courses	*For any of the core Math courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:50 **or** 22M:55 (3 s.h.)	
22C:16 (4 s.h.)	
22S:120 Probability and Statistics (4 s.h.)	
6E:100 Econ for Business Decision Making (3 s.h.) **or** 6E:104 Micro Economics Theory (3 s.h.)	
6K:176 Managerial Decision Models (3 s.h.)	
List of Electives	(2 for BA, 4 for BS) Select from Group I and Group II.
Group I (one for BA, two for BS)	**Group II** (one for BA, two for BS)
22M:72 (Elementary Numerical Analysis)	
22M:100 (Differential Equations)	6E:105 (Macroeconomics)
22M:140 (Continuous Mathematical Models)	6F:100 (Introductory Financial Management)
22M:150 (Intro to Discrete Math)	6F:111 (Investment Management)
22M:151 (Discrete Math Models)	6K:100 (Operations Management)
22M:152 (Theory of Graphs)	6K:182 (Applications Database Management Systems)
22M:174 (Optimization Techniques)	6K:183 (System Analysis and Design)
22C: or 22S: more advanced than core courses	6K:184 (Introduction to Data Communications)

Mathematics and Physics

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics and Physics**	**This program requires 5 core courses plus a minimum of 6(BA) or 8(BS) electives. The core courses are in Mathematics; the electives are taken in Mathematics and in Physics.**
Core Courses	*For any of the core courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.) **or** 22M:47 Linear Algebra and Differential Equations for Scientists (3 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.) **or** 22M:48 Vector Calculus for Scientists (3 s.h.)	
22M:50 **or** 22M:55 (3 s.h.)	
List of Electives	(6 for BA, 8 for BS) Select 3 or more from Group I (with at least 2 in Physics), and select all from Groups I and II (at least 3 from Math).
Group I (three or more, at least two in physics)	**Group II**
29:118 (Statistical Physics)	22M:115, 116 (Intro to Analysis I, II)
29:115 (Intermediate Mechanics)	22M:170 (Numerical Analysis: Nonlin Eq & Approx)
29:129, 130 (Intermediate Elec and Mag)	22M:171 (Numerical Analysis: DE & Lin Alg; (*170 & 171 are independent of each other*)
29:140, 141 (Intro to Quantum Mechanics I & II)	22M:142 (Nonlinear Dynamics with Numerical Methods)
22M:100 (Intro to Differential Equations)	22M:144 (Partial Differential Eqs w/ Numerical Methods)
22M:118 (Complex Analysis)	Any course numbered 29:100 or above (except 29:128, 131, 132, 133; 29:103 with advisor's approval only)

Mathematics and Risk Management/Insurance

Department of Mathematics (Program C) **BA/BS subtrack:** **Mathematics and Risk Management/Insurance**	**This program requires 7 core courses plus a minimum of 4(BA) or 6(BS) electives. The core courses are in Mathematics and Finance ; the electives are taken in Mathematics, Statistics, College of Engineering and in the College of Business.**
Core Courses	*For any of the core Math courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	
22M:27 Intro to Linear Algebra (4 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:50 **or** 22M:55	
6F:102 Principles of Risk Management & Insurance	
6F:104 Corporate & Financial Risk Management	
List of Electives (4 for BA, 6 for BS)	For the BA, a student must take at least one elective course from Group I, two from Group II, and one from Group III. For the BS, a student must take at least two elective courses from each of the three groups.
Group I	**Group II**
22M:50, 55, 72, 96, 100 or any 22M course numbered 22M:115 or higher, excluding 22M:195-199.	6F:103 Property and Liability
	6F:105 Life and Health Insurance
	6F:106 Employee Benefit Plans
Group III	**Group III continued**
6A:120 Financial Accounting and Reporting	
6F:100 Introduction to Financial Management	6F:126 Real Estate Process
6F:111 Investment Management	6J:156 Dynamics of Negotiations
6F:113 Fixed Income Securities	6J:162 Leadership and Personal Development
6F:114 Commercial Banking	6M:139 Sales Management
6F:116 Futures and Options	22S:112 Introduction to Actuarial Science
6F:117 Corporate Finance	056:054 Engineering Economy

Mathematics and Statistics and Actuarial Science

Department of Mathematics (Program C) BA/BS subtrack: Mathematics + Statistics and Actuarial Science	**This program requires 5 core courses plus a minimum of 6(BA) or 8(BS) electives. The core courses are in Mathematics; the electives are taken in Mathematics and in Statistics and Actuarial Science. Note that Statistics and Actuarial Science does not offer a BA degree.**
Core Courses	*For any of the core courses, higher-level Mathematics courses may be substituted, if approved by the Department.*
Calculus I and Calculus II (8 s.h.)	Any of the sequences 22M:25-26, 22M:31-32 is acceptable.
22M:27 Intro to Linear Algebra (4 s.h.)	
22M:28 **or** 22M:56 Multivariable Calculus (4 s.h.)	
22M:50 **or** 22M:55 (3 s.h.)	Note that 22M:55, 56 are required for the BS in Actuarial Science
List of Electives	Students must take at least six elective courses (each 3-4 s.h.) for the BA [at least eight for the BS] from the following list. The electives must include at least **two** from Mathematics and at least **four** from Statistics and Actuarial Science.
Mathematics 22M: (at least two)	22M:50, 55, 72, 96, 100, or any course numbered 22M:115 or higher, excluding 22M:195-199.
Statistics and Actuarial Science 22S: (at least four)	Any of the 22S: courses that can be counted towards one of the BS majors offered in that department.

Note: It is very easy to get the double major a BS in Actuarial Science and a BS in Mathematics (PROGRAM C Mathematics + Statistics and Actuarial Science). Students satisfying the requirements for the BS in Actuarial Science (which include Calculus I and II, 22M:27, 22M:55-56) need take only two additional approved Mathematics (22M) courses. Two recommended choices are 22M:72 and 22M:100.

CALCULUS COURSES

We have two alternate sequences. They are distinct enough that we do not encourage students to switch from one version of Calc I to another version of Calc II unless they are doing quite well. At the same time, the sequences are all intended to be equally useful preparation for second year courses, so it is easy to move on, regardless of which sequence is taken for Calculus I-II.

22M:25-26 CALCULUS, I-II

This is the traditional sequence taught here and around the world for many years. The course focuses on the ideas of Calculus, computational skills, and standard applications. This is the standard course for all students majoring in Math, CS, Physics, Stats., etc.

ENGINEERING CALCULUS

In the past we offered 22M:35-36 Engineering Calculus I-II. This sequence, which was very similar to 22M:25-26, will not be offered after Fall 2002. It is replaced by 22M:31 Engineering Mathematics I: Single Variable Calculus and 22M:32 Engineering Mathematics II: Multivariable Calculus. 22M:31 and 32 cover many of the topics covered in 22M:25-26, and 22M:32 also gives an introduction to multivariable calculus. Students who have taken 22M:31 and 32 and want to major in mathematics should see the Director of the Math Undergraduate Program. Also, see Transfers from Engineering (page 23) and Appendix R: Regression and Duplication (page 28).

SAMPLE SCHEDULES

These programs are illustrations. Consult with your advisor regarding your individual goals, background, taste, etc. Because PROGRAM C is so individualized, we have not included sample PROGRAM C schedules.

PROGRAM A BS (Eventual Ph.D.)

	Fall	**Spring**
Year 1	Calculus I	Calculus II, 27
Year 2	55, C16	56, 50, or CS course
Year 3	100, 120 (or 50)	121, S120
Year 4	115, 132	116, 133

PROGRAM A BS (INDUSTRY, GOVT., OR GRAD. SCHOOL IN APPLIED MATH.)

(Think also about doing PROGRAM C)

	Fall	**Spring**
Year 1	Calculus I	Calculus II, 27
Year 2	55, C16	56, CS course
Year 3	50, 100, S130	118, S131
Year 4	more**, more**	more**, more**

more** means another course such as M115-116, 140, 142 144, 151, 170, 171

PROGRAM B BA (Teaching Certification)

	Fall	**Spring**
Year 1	Calculus I	Calculus II, 27
Year 2	28, 22C:16, 7P:075**	50, 70, 7E/S:102,* 7S:190,* 7S:195*
Year 3	55, 22S:120, 7S:95,** 7S:100	151, 7S:134, 7B:180
Year 4	150, 7S:135, 7U:100	(Student Teaching) 7S:187, 7S:191, 7S:192

* must be taken during the first semester in the College of Education

** recommended that these be taken as soon as possible

FOUR-YEAR GRADUATION PLAN

The following checkpoints list the minimum requirements students must complete by certain semesters in order to stay on the University's four-year graduation plan. (Courses in the major are those required to complete the major; they may be offered by departments other than the major department.)

Much of the work in mathematics must be taken in sequence, so students must begin major requirements as early as possible. The BA degree requires 11 courses, the BS 13. There are three programs to choose from, so individual plans of study must be worked out carefully. In addition to these checkpoints, **students must select a PROGRAM by the end of the third semester and remain in that program until they graduate in order to stay on track for the four-year graduation plan.**

Before the third semester begins: course work through Calculus II and at least one-quarter of the semester hours required for graduation
Before the fifth semester begins: two or three more courses in the major and at least one-half of the semester hours required for graduation
Before the seventh semester begins: three or four more courses in the major and at least three-quarters of the semester hours required for graduation
Before the eighth semester begins: two or three more courses in the major
During the eighth semester: enrollment in all remaining course work in the major, all remaining GERs, and a sufficient number of semester hours to graduate.

DOUBLE MAJORS AND DOUBLE DEGREES

In the University, a "double major" means satisfying the BA requirements of two departments or satisfying the BS requirements of two departments; a "double degree" means satisfying the BA requirement of one department and the BS requirement of another department. Some courses can be counted towards both sets of requirements, so in the right situation, a double-major or a double degree is surprisingly efficient. A student in Mathematics may earn an additional University of Iowa baccalaureate degree from another UI college concurrently. A student earning baccalaureate degrees from two colleges is generally referred to as participating in the "combined degree program". In order to earn additional baccalaureate degrees from different colleges, the student must be admitted to those colleges. All requirements for the additional degrees must be satisfied, including the requirements for the majors and for the appropriate General Education Programs. Students also must satisfy the residence requirements of The University of Iowa and of the colleges.
Additional information is available in the cooperating colleges' student services offices. Students seeking additional degrees from different UI undergraduate colleges are urged to review all requirements with college advisors or staff as soon as possible.

Majors in **Computer Science**, **Physics and Astronomy**, or **Statistics and Actuarial Science** take a number of core math major courses as part of the requirements for those departments. At the same time, various courses in those departments can be counted towards a math degree. So it is especially easy for students to double major or to get two degrees in Mathematics and one of these areas. Assuming a student takes the mathematics and other courses listed by those departments for their degrees, here are the quickest ways to add a Math major - see PROGRAM C for more details. See also **MINOR IN MATHEMATICS**.

Students in **Engineering**, **Business**, **Economics**, and **Biological Sciences** also may find good routes to a double major or a double degree. See also **MINOR IN MATHEMATICS**.

Computer Science

- BA in Computer Science plus 4 more math courses (if you took 22M:27 or 22M:47) ==> BA in Mathematics under PROGRAM C. The four additional math courses are {22M:28 or 56}, {22M:50 or 55}, and {two of 22M:50, 55, 72, 96, 100 or others listed} - see PROGRAM C for details.
- BS in Computer Science (with 22M: courses, e.g. 22M170-171) used to satisfy the CS "Advanced Courses" requirement) plus 2 more math courses ==> BS in Mathematics under program C. The two additional math courses are {22M:28 or 56}, {22M:50 or 55} - see PROGRAM C for details .

Physics and Astronomy

BS in Physics or BS in Astronomy plus 4 more math courses ==> BS in Mathematics under PROGRAM C. The 4 additional math courses are {22M:50 or 55} and {three of 22M:100, 115, 116, 118,142,144, 170,171} - see PROGRAM C for details.

Statistics and Actuarial Science

- BS in Statistics (any of their tracks) plus 4 more math courses ==> BS in Mathematics under PROGRAM C. The four additional math courses are {22M:28 or 56}, {22M:50 or 55}, and {two of 22M:50, 55, 72, 100 or others listed}. In the Statistics track "Mathematical Statistics", 22M:55 and {22M:28 or 56} already are required, so the math major can be added just by taking two more math electives, {two of 22M:50, 55, 72, 96, 100 or others listed} - see PROGRAM C for details.
- BS in Actuarial Science plus 2 more math courses ==> BS in Mathematics under program C. The additional courses are {two of 22M:50, 72, 96, 100 or others listed} - see PROGRAM C for details.

Engineering

An Engineering major who wants to earn an additional degree in a Liberal Arts and Sciences area needs to satisfy General Education requirements in the CLAS and accumulate a total of 158 s.h. in both colleges with at least 30 s.h. in CLAS. So this option is for someone who wants additional breadth and is willing to work about one extra year. Given that some number of Humanities and Social Science courses are required for Engineering degrees, and that there will be additional math courses for the math major, the package may be more feasible than one might think at first.

The old standard Engineering mathematics sequence (22M:35, 36, 40, 41, 42) plus one additional math course {one of 22M:72, 127 (recommended), 140, 142, 144, 170, 171} is counted as satisfying the mathematics PROGRAM A core requirements for Calculus I-II, 22M:27, 56, and 100. So a student would need 6 additional math (or CS, Stats) courses for a BA in Mathematics under PROGRAM A. The additional courses are 22M:50, 55, and {four more courses from the many 22M:, 22C:, 22S: options listed in PROGRAM A}. The new standard Engineering mathematics sequence (22M:31, 32, 33, 34, 37) only total 16 s.h. while the PROGRAM A core requirement totals 19 hours. Students must take 3 additional hours. These may be gotten by taking an additional class from the above list. For more details, and for engineering students who have not completed the entire Engineering Mathematics sequence, see **TRANSFER FROM ENGINEERING TO MATHEMATICS.** Some 22C or 22S courses may already be part of the Engineering major, and these might also be applicable to the math major; but one still needs the total 30 s.h. in Liberal Arts.

Business, Economics, Biological Sciences
These areas do not require a lot of core math major courses. But there still is an advantage because of PROGRAM C. Students in these areas who enjoy mathematics are encouraged to consider one of the pre-approved PROGRAM C templates or propose a new one. Note that a degree in Business is a BBA and hence a BA or BS in Mathematics would be a second degree and would require at least 30 s.h. in CLAS. Once again, another option is a minor in Mathematics - see below.

MINOR IN MATHEMATICS

A minimum of 15 semester hours credit earned in Department of Mathematics courses; at least 12 of these 15 semester hours must be taken at the University of Iowa in advanced courses offered by the Department of Mathematics; neither transfer credit nor credit by examination is accepted toward the 12 semester hours of advanced work; advanced courses are 22M:27, 22M:28, 22M:33 (old 22M:40), 22M:34 (old 22M:41), 22M:37(old 22M:42), 22M:47, 22M:48 and all courses numbered 22M:50 or higher except 22M:81, 22M:104, 22M:109 and 22M:195. Students who have taken 22M:31, 22M:32, 22M:33, 22M:34, and 22M:37 at Iowa may satisfy the advanced course requirement by taking one additional advanced course numbered 22M:50 or higher except 22M:56. A GPA of at least 2.00 is required and no course counted toward the minor may be taken pass/nonpass.

A sample list that qualifies for a minor in Mathematics is

Calc I, Calc II, 22M:27, 22M:28, 22M:100, one more 22M: post-calculus course.

or

22M:31, 22M:32, 22M:33, 22M:34, 22M:37, one more 22M:post-calculus course.

ELEMENTARY EDUCATION MATHEMATICS SPECIALIZATION

Students majoring in Elementary Education need to develop an area of specialization. Please see the Department of Teaching and Learning elementary education advising office (N261 LC, 335-5612) for details. Here is the course list for the Mathematics specialization; the total must be at least 24 s.h. of 22M:, 22C:, 22S: courses counting towards graduation, plus the Methods course. In the list below, courses marked (E) are specifically for Elementary Ed. majors and certified teachers. Courses marked (S) are part of the Secondary-School Teaching track, so they may be attractive to students seeking both certifications. Note that a student completing the UI Secondary Mathematic Teacher Education Program is certified (in Iowa) for mathematics in grades 7-12.

One of the following

(E)	22M:12	Theory of Arithmetic (was 22M:4)	3 s.h.
(S)	22M:50	Introduction to Abstract Algebra I	3 s.h.

One of the following

(E)	22M:81	Geometry for Elementary Teachers	3 s.h.
(S)	22M:70	Foundations of Geometry	3 s.h.

One of the following

	22C:1	Survey of Computing	3 s.h.
	22C:5	Problem Solving and Computing	3 s.h.
(S)	22C:16	Computer Science I: Fundamentals	4 s.h.

One of the following

	22M:9	Elementary Functions	4 s.h.
	22M:10	Finite Mathematics	4 s.h.
	22M:13	Mathematics for Business	4 s.h.
	22M:15	Mathematics for the Biological Sciences	4 s.h.
(S)	22M:27	Introduction to Linear Algebra	4 s.h.
	22M:33	Engineering Math III (old 22M:40)	2 s.h.

One of the following

	22M:11	Introduction to Calculus with Applications	4 s.h.
	22M:16	Calculus for the Biological Sciences	4 s.h.
	22M:17	Calculus and Matrix Algebra for Business	4 s.h.
(S)	22M:25	Calculus I (or 22M:21, 31, or 35)	4 s.h.
	22M:31	Engineering Calculus I: Single Variable Calculus	4 s.h.

One of the following

	22S:2	Statistics and Society	3 s.h.
	22S:8	Statistics for Business	4 s.h.
	22S:25	(7P:25) Elem. Statistics and Inference	3 s.h.
	22S:39	Prob. and Stat. for Engr. and Phys. Sci.	3 s.h.
	22S:102	(7P:143) Intro. to Statistical Methods	3 s.h.
(S)	22S:120	Probability and Statistics	4 s.h.

Electives

Additional courses 22C:, 22M:, 22S: to achieve a total of 24 s.h. from these departments.

Methods Course

	07E:173	Methods: Middle School Mathematics	3 s.h.
		(This 3 s.h. is not included in the required 24 s.h. in mathematics)	

TRANSFERS FROM ENGINEERING TO MATHEMATICS

If you wish to transfer from an Engineering major to a (PROGRAM A) Mathematics major, you have a special option for satisfying the particular Math course requirements: {Calculus I-II, 22M:27, 56, 100}. (For PROGRAM B or C, consult the Department.)

Old Engineering sequence (22M:35, 36, 40, 41, 42)

If you took only 22M:35-36, just start the other Math courses. If you have completed the standard Engineering sequence 22M:35, 36, 40, 41, 42 (16 s.h.), you may take one additional course (3 s.h.) from the list: 22M:72, 127, 140, 142, 144, 170, 171, and the resulting total (19 s.h.) will be considered to satisfy the requirements for Calculus I-II, 27, 56, 100 (also 19 s.h.). The additional course may not be counted toward any other of the requirements for the mathematics degree. (Advice: Since Math majors take 22M:55 before 56, take 55 quickly to fill that gap.)

Even if you have gone beyond Calc I-II in the Engineering sequence, you may still want the extra security of taking M27, (55-)56, and 100. You are welcome to do this, but there will be some reduction in credits because of "duplication" or "regression" (not crimes, simply a statement that a lot of the new course material was covered in previously taken courses). For example, M40 + M27 = 4 s.h. total credit, and M42 + M28 = 5 s.h. total credit.

New Engineering Sequence (22M:31, 32, 33, 34, 37)

If you completed only:

31: take 22M:26 + regular math sequence;

31, 32: take 22M:27 + regular math sequence;

31, 32, 33: same as 31/32 but may take 27 for a total of 4 s.h. for {33, 27} or may substitute 127

for full credit (encouraged);

31, 32, 33, 34: this sequence only totals 13 s.h. while 25, 26, 27, 28/56, 100 totals 19 s.h. Student must take an additional 6 s.h.. This may be gotten from extra partial hours (27 for two more s.h.) or by taking additional classes from 22M:72, 127, 140, 142, 144, 160, 170, 171. The two additional courses is the encouraged way.

31, 32, 33, 34, 37: this sequence only totals 16 s.h. while 25, 26, 27, 28/56, 100 totals 19 s.h. Students must take an additional 3 s.h. This may be gotten by taking an additional class from 22M:72, 127, 140, 144, 160, 170, 171.

In general we encourage students to move forward and not take courses such as 26, 27, 28/56, or 100 to pick up small bits of material missed from 32, 33, 34.

SPECIAL OPPORTUNITIES

FINANCIAL AND PERSONAL DEVELOPMENT

There are many opportunities to enhance your education and perhaps earn extra money while studying math. These include internships, study abroad, assisting faculty in research projects, summer institutes, and scholarships. There are several ways to get information about the availability of such programs:

- Check the bulletin boards in MLH. Many announcements are posted on the Math Department Bulletin boards in the hallway of the first floor or ground floor of MacLean Hall. Watch particularly the space at the left-hand end of the longer board on the first floor. There is an annual competition for a small scholarship in the Mathematics Department and greater opportunities College-wide.
- Check the departmental web site for lists of opportunities for Mathematics students. (Go to Degree Programs and then to Undergraduate Major's Page.)
- Become a member of SUMS, the Math Club; the newsletter may announce opportunities and you'll learn more from other students.
- Check the financial aid office, the graduate programs offices, or the Career Center (100 Pomerantz Center, Suite C310).
- Check your UI email regularly: We use that method a lot to communicate with majors.
- Check the AMS websites: www.ams.org/careers-edu/internships.html or

  www.ams.org/careers-edu/undergrad.html/#jobs

UNDERGRADUATE RESEARCH ASSISTANTSHIPS

The Department (or individual professors with NSF or similar grants) provides stipends to several undergraduates each semester to work with professors on their research. The work might be supportive (e.g. helping compile a bibliography), pedagogical (e.g. helping develop innovative classroom materials), or doing basic research (e.g. computer experiments or proving theorems). The ideal situation is where a student and professor have gotten to know each other and jointly request support for the project; but we often bring together students and faculty, so you don't need a sponsor in order to apply. You can get the application form from the Department secretary; or online at http://www.math.uiowa.edu/RA-APP.pdf. The best time to apply is before the beginning of Fall semester.

SUMMER RESEARCH

Each year, a number of colleges around the country have summer "REU" programs (Research Experience for Undergraduates). In particular, we offer a summer REU program at Iowa. These programs are funded by the NSF, and provide stipends for living expenses (and maybe some more) as well as the chance to work with interesting professors on interesting mathematical projects. The Math Department secretary has a file of announcements of these programs, which we encourage you to explore. They are also listed on the Undergraduate Major's Page or see www.ams.org/employment/reu.html. Also, a number of faculty in our Department have NSF grants that would enable them to support an undergraduate student for summer research. If you have gotten to know some professors and would like to work with them, just ask. If you are interested in this but do not have a particular professor in mind, ask the Department to help you make a contact.

THE MATH CLUB

The Math Department sponsors an undergraduate Math club, affiliated with the Mathematical Association of America. Along with membership in the local group come membership, publications, and information from the MAA. The club usually meets about once a month for topics of mathematical interest and socializing. It's a great way to see that there really are other math majors, to find out which professor really is that great a teacher, and to see some interesting talks, films and visitors.

HONORS IN MATHEMATICS

Participating in the Honors Program has tangible benefits such as special access to Hancher events and other cultural and social opportunities, and the pleasure of getting to know other students who are excited about their studies. The Honors Program also has funds for student research for honors projects and for travel for presentation of research. Any undergraduate student with UI cumulative GPA of 3.33 or higher may join the College of Liberal Arts and Sciences Honors Program; interested students should contact the Honors Program office at 420 Blank Honors Center.

In order to graduate with honors in mathematics, a student must be registered in the CLAS Honors Program, must complete the regular requirements for an undergraduate major in mathematics with a GPA of at least 3.4, and must either

complete an honors project
or
include the courses 22M:115-116 and 120-121 with at least a B average

For further information contact the Department's Honors Advisor Prof. David Stewart.

AMS UNDERGRADUATE MATHEMATICS MAJORS PAGE

The American Mathematical Society (AMS) has an undergraduate math major's page at www.ams.org/employment/undergrad.html. It has links to information about graduate school in mathematics, summer programs, semester programs, math competitions, careers, and jobs and internships.

PREPARING FOR A JOB OR GRADUATE SCHOOL

Your prospects are excellent; Math majors are very employable, with good starting salaries. We have annually interviewed recent graduates from our department and found that nearly every one (there were some we could not contact) is working in an area where mathematics is used, is teaching mathematics, or is in a graduate program. Opportunities in all areas, and the national shortage of mathematic teachers in particular, make a UI mathematics degree very valuable.

If you are brilliant, you can afford to be narrowly specialized; people will accept many limitations on a person who offers some spectacular talent. But for most of us, breadth is an important companion to strength. In addition to building your mathematical knowledge and abilities, you should work to be an excellent writer and speaker. And you should develop several interests: For someone seeking a job, that probably means taking courses in some other area(s) that you like and where mathematics is used; for someone aiming at graduate school in mathematics, that means taking (and doing well in) some of our senior/masters level courses.

For all future directions, the following are important:

- Faculty recommendations
- Ability to communicate (both spoken and written)
- Transcript (good program, respectable grades)
- For graduate or professional schools (Business, Law, Medicine), test scores also are important.

If at all possible, get to know the faculty members teaching your courses. Most faculty members welcome genuine interest and are quite willing to discuss your academic situation. Our professors are expected to be accomplished and active scholars. They went into mathematics for the same reasons you are: they liked it and they're good at it; so they are bound to respond well to your interests. An important bonus is that getting better acquainted with faculty members will make it easier for them to write informed and individualized letters of recommendation for you when they are needed.

It's also important to develop your communication skills. You will almost certainly be using mathematics in a research team, teaching, or selling position, and your fitness for employment or graduate school will be partly evaluated through interview or essay.

But who hires you, and what will you be doing? Some answers are obvious, such as high school or (with advanced degrees) college teaching. Insurance companies hire math majors (as well as Stats/ActSci majors) for jobs in actuarial analysis. Math majors work in the computer industry. Government agencies such as the Commerce Department, Agriculture Department and National Security Agency hire mathematicians, the first two for data analysis, the latter for theoretical cryptography research. Investment firms hire math majors to analyze trends and optimize portfolios. Airlines hire math majors to analyze routing and scheduling. Large consulting companies welcome mathematics as one of several good preparations. A corporation may welcome a math major to a job that doesn't really involve mathematics, but just because that person has demonstrated the ability to understand complicated situations and solve problems. Also, check out the AMS website at www.ams.org/careers-edu/undergrad.html#jobs.

Appendix G: GRADE AND CREDIT REQUIREMENTS

- A minimum grade-point average of 2.0 in the major is required to obtain a degree in mathematics.
- A minimum g.p.a. of 2.7 in the major is required for secondary school teacher certification.
- Additional degree requirements concerning transfer credit, credit by correspondence, credit by examination, cumulative grade-point average, and so forth, are discussed in the College of Liberal Arts and Sciences section of the UI Catalog.
- At least 15 semester hours of post-calculus courses applied towards the major requirements must be taken at The University of Iowa.
- Students may substitute higher level courses in the same area for any of the requirements, but this requires the advisor's permission.

Appendix R: REGRESSION, DUPLICATION and SECOND GRADE OPTION

The Department of Mathematics offers many introductory level courses; this raises questions of duplication. At the same time, many of our courses build on the introductory courses or others, so there are situations of regression. Finally, because students' interests may change, we need to be clear about when one course can be used as second-grade-only(SGO) for another course.

We hope you find this statement of current Mathematics Department policies clear and convenient. We very much welcome any comments or suggestions you may have on these (or other) matters, so that we can better serve the many students taking Math courses.

GUIDING PRINCIPLES

We include some examples here; but these are just to illustrate the policies; the complete lists are given in the subsequent sections.

1. We offer many service courses, and also have parallel tracks for majors; so course number is not a safe guide for which course is more advanced than which other. This is why the Regression list looks complicated.

For example, 22M:28 is much more advanced than 22M:31 or 22M:35. On the other hand, 22M:10 is independent of nearly all other undergraduate courses, so there is no Regression in taking 22M:10 after taking 22M:100.

2. There are groups of similar courses; within a group, usually, any two courses = *duplication*, and any course can be used as *SGO* for any other. The courses really are different in subject emphasis and sometimes even a bit different in level, so students should be advised carefully in selecting courses. These approximate groupings are a compromise, to give students and advisors reasonable flexibility.

For example, any of the "short calculus" courses 22M:11, 16, 17 *duplicates* any other, and can be used to *SGO* any other.

Note: Other departments may distinguish between these courses; for example, we do NOT encourage a biological science department to accept 22M:11 in lieu of 22M:16, nor a business program to accept 22M:11 or 16 in lieu of 22M:17.

3. The group-numbers DO represent increasing level.
For example, taking any course in Group 2 after passing a course in Group 3 constitutes *regression*.

4. Some courses have substantial overlap but are different enough to justify having students take both, with a reduction in total credits.
The five cases of this are:
22M:32 + 26 = 6 s.h. total,
22M:32 + {28 or 56} = 6 s.h. total,
22M:32 + 26 + {28 or 56} = 10 s.h. total,
22M:{33 or 40} + 27 = 4 s.h. total, and
22M:{37 or 42} + {28 or 56} = 5 s.h. total.

Department of Mathematics POLICY ON *DUPLICATION* AND *SECOND GRADE OPTION*

To meet the needs of diverse students and other departments, we offer several approaches to Calculus at each of several levels. Each course is designed with a certain emphasis and sequencing of topics. We encourage students and advisors to be careful in selecting appropriate courses. And we encourage departments to maintain the course distinctions.

Students may change majors, and it is desirable to allow alternatives for SGOs. For example, a student moving from Biology to Business would be better served taking 22M:17 than repeating 22M:16. On the other hand, if the student intends to remain a Biological Sciences major, then the student should be required to SGO 22M:16 with 22M:16 (or a Group II course - see below). Similarly, a student cannot use 22M:11 to satisfy the College of Business requirement. *Our Department policy on SGOs is not intended to change any policies of other departments regarding which courses satisfy their requirements.*

There are several groups of similar courses; within a group, taking any two courses constitutes *duplication*, and any course in a group can be used as *SGO* for any other in that same group.

Group 1: Math Primarily for Elementary Ed Majors	
22M:004	Theory of Arithmetic (not offered after Spring 2004)
22M:006	Logic of Arithmetic (first offered Fall 2004)
22M:012	Theory of Arithmetic (first offered Fall 2004)

Note: 22M:012 is intended for Math specialists. Check with Elementary Ed Advisor as to whether 006 or 012 is the appropriate course.

Group 2: Pre-Calculus	
22M:009	Elementary Functions
22M:013	Mathematics for Business
22M:015	Mathematics for the Biological Sciences

Group 3: Short Calculus Courses	
22M:011	Introduction to Calculus with Applications
22M:016	Calculus for the Biological Sciences
22M:017	Calculus and Matrix Algebra for Business

Group 4: First Semester Calculus	
22M:025	Calculus I
22M:031	Engineering Mathematics I: Single Variable Calculus
22M:035	Engineering Calculus I (no longer offered)
22M:045	Accelerated Calculus with Applications I (no longer offered)

Group 5: Second Semester Calculus	
22M:026	Calculus II
22M:032	Engineering Mathematics II: Multi-Variable Calculus
22M:036	Engineering Calculus II (no longer offered)
22M:046	Accelerated Calculus with Applications II (no longer offered)

Group 6: Calculus of Several Variables (special rules apply to this group – see following pages)	
22M:028	Calculus III
22M:037	Engineering Mathematics V: Vector Calculus
22M:042	Vector Calculus for Engineers (no longer offered)
22M:048	Vector Calculus for Scientists
22M:056	Fundamental Properties of Spaces and Function II

Group 7: Differential Equations	
22M:34	Engineering Mathematics IV: Differential Equations
22M:41	Differential Equations for Engineers (no longer offered)
22M:47	Linear Algebra and Differential Equations for Scientists

Department of Mathematics POLICY ON *REGRESSION*

In the courses 22M:001 - 22M:99, the general assumption is that {higher number course} → {lower number course} constitutes *regression*. The exceptions to this principle (i.e. it is OK to take the lower number course after the higher number course) are as follows:

It is OK to take	**even after**	**because**
22M:14 anything	anything 22M:14	Freshman Seminars are independent of other courses
22M:10 any of 22M: 4-9	anything except 22M:15 22M:10	the course 22M:10 is independent of the elementary functions, calculus, and algebra courses.
22M:4, 6, 12, or 22M:81 anything	anything 22M:4 or 22M:81	the material is specialized and independent of other courses. Can get credit for only one of 22M:4, 22M:6, or 22M:12.
[There used to be an item saying one can take 22M:1 or 22M:2	after taking 22M:3.	But since they all are remedial, and have no graduation credit, the issue of regression is moot.
22M:5	22M:6, 10, 11, 12, 13, 15, 16, 17	even though Trig. is supposed to be a high-school course, we and AAC want to enable students to prepare well for a full year Calculus sequence if their major or career goals evolve to make that appropriate.

It is OK to take	**even after**	**because**
22M:11	22M:12, 13, 22M:15	22M:12 is specialized material; 22M:13 and 22M:15 are versions of pre-calculus, and 22M:11 is a version of calculus.
Any second-semester calculus course (i.e. 22M:22, 26, 36, 46)	any first semester calculus course (i.e. 22M:21, 25, 31, 35, 45)	while we do not generally encourage changing a student's "flavor" of calculus from one semester to the next, certainly there is no "regression" in going from Calc I to Calc II.
22M:26	22M:32	The student receives only 6 s.h. totals. However, 22M:32 + 22M:26 + {22M:28 or 56} = 10 total s.h. since 26 + {28 or 56} covers all of 22M:32.
22M:27, 22M:40, or 22M:33 <u>Note:</u> Taking 22M:27 And 22M:27→22M:40 or 22M:33 The rule is: 27 + {33 or 40} in either order ⇒ total 4 s.h.	Any other course 22M:28-48, 22M:70, 72, 81, except 47 22M:40 or 22M:33 IS *regression* which allows the 40 or 33 → 27 for 2 additional s.h. and also accomplishes the regression rule that 27 → 33 or 40 ⇒ no additional s.h.	The algebra courses are largely independent of the calculus courses. Is ok because there is much more material in 22M:27 than in 22M:33 or 22M:40. However, the student receives only 4 s.h. total credit, because the material of 22M:33 and 22M:40 is repeated in 22M:27. despite the higher number. Note that 22M:33 and 22M:40 are the same course.

It is OK to take	**even after**	**because**
22M:28 or 22M:32	22M:31, 33, 35, 36, 41, 45, 46, 47	There is no "regression" in going from Calc I or Calc II to multivariable calculus; also 22M:41 does not assume multivariable calculus as 22M:100 does.
22M:28 or 22M:56	22M:32, 42	22M:28 and 22M:56 are 4 s.h.; there is more material, at greater depth, than in 22M:32 or 42. However, the student receives only 5 s.h. (resp. 6) total credit if 22M:42 (resp. 22M:32) is taken, because most of the material of 22M:42 is included in 22M:28 and in 22M:56.
And 22M:28 $\rightarrow$22M:42 or 22M:32, 22M:37, or 22M:48	IS *regression*	despite the higher number.
22M:34, 41	22M:37, 42, 45, 46	There is no "regression" in going from Calc I or Calc II to differential equations; also vector calc (22M:42) does not assume diff. eq (22M:41).

Appendix F: Mathematics Faculty and Research Interests

Name	Office	Phone	Email	Research Area
Anderson, Daniel	1L MLH	335-0773	dan-anderson@uiowa.edu	Commutative Algebra
Atkinson, Kendall (emeritus)	1B MLH	335-0766	atkinson@math.uiowa.edu	Numerical Analysis
Ayati, Bruce	25G MLH	335-0797	ayati@math.uiowa.edu	Mathematical Biology, Applied Numerical Mathematics
Baker, Richard	B20C MLH	335-0719	baker@math.uiowa.edu	Functional Analysis
Bleher, Frauke	225K MLH	335-1514	fbleher@math.uiowa.edu	Rep. Theory of Groups & Algebras
Camillo, Victor	1E MLH	335-0769	camillo@math.uiowa.edu	Algebra, Rings, & Modules
Curto, Raul	225H MLH	335-0762 & 335-2615	rcurto@math.uiowa.edu	Functional Analysis
Curtu, Rodica	B1E MLH	335-0744	rcurtu@math.uiowa.edu	Math. & Comp. Neuroscience, Math. Biology, App. Dynamical Systems, Bifurcation Theory
Darcy, Isabel	B1H MLH	335-0778	idarcy@math.uiowa.edu	Topology, Mathematical Biology
Durumeric, Oguz	B20F MLH	335-0774	odurumer@math.uiowa.edu	Differential Geometry
Fang, Hao	325H MLH	335-0722	haofang@math.uiowa.edu	Differential Geometry
Frohman, Charles	B1F MLH	335-2543	frohman@math.uiowa.edu	Topology
Fuller, Kent (emeritus)	25M MLH	335-0792	kfuller@math.uiowa.edu	Rings, Modules, & Representation Theory
Gatica, Juan	1R MLH	335-0777	gatica@math.uiowa.edu	Biomath, Diff. Equations, Fixed Point Theory

Goodman, Fred	325G MLH	335-0791	goodman@math.uiowa.edu	Functional Analysis
Han, Weimin	B1D MLH	335-0770	whan@math.uiowa.edu	Numerical Analysis
Jay, Laurent	225L MLH	335-0898	ljay@math.uiowa.edu	Numerical Analysis
Johnson, Norman	1A MLH	335-0765	njohnson@math.uiowa.edu	Finite Geometry, Combinatorics
Jorgensen, Palle	25B MLH	335-0782	jorgen@math.uiowa.edu	Functional Analysis, Mathematical Physics
Khurana, Surjit	B20B MLH	335-0756	surjit-khurana@uiowa.edu	Functional Analysis, Measure Theory
Kirk, William A.	25H MLH	335-0788	william-kirk@uiowa.edu	Nonlinear Functional Analysis
Krishnamurthy, Muthu	1M MLH	335-0899	mkrishna@math.uiowa.edu	Representation Theory, Number Theory
Kutzko, Philip	B20D MLH	335-0758	pkutzko@blue.weeg.uiowa.edu	Representation Theory, Number Theory
Lediaev, John (emeritus)	25E MLH	335-0785	jlediaev@math.uiowa.edu	Philosophy of Mathematics
Li, Tong	325D MLH	335-3342	tli@math.uiowa.edu	Nonlinear Hyperbolic & Parabolic PDEs, Shock Wave Theory
Li, Yi	14A MLH	335-0714	yli@math.uiowa.edu	Partial Differential Equations
Lin, Bor-Luh	25D MLH	335-0784	bllin@math.uiowa.edu	Banach Space Theory
Mitchell, Colleen	225E MLH	335-3813	mtchll@math.uiowa.edu	Mathematical Biology
Muhly, Paul	225M MLH	335-0759	pmuhly@math.uiowa.edu	Functional Analysis
Nelson, George	225D MLH	335-0796	gnelson@math.uiowa.edu	Mathematical Logic

Radulescu, Florin	1P MLH	335-0775	radulesc@math.uiowa.edu	Functional Analysis
Randell, Richard	1C MLH	335-0767	randell@math.uiowa.edu	Differential Topology
Roseman, Dennis	B1J MLH	335-0779	roseman@math.uiowa.edu	Topology
Seaman, Walter	325K MLH	335-0795	seaman@math.uiowa.edu	Differential Geometry
Simon, Jonathan	1D MLH	335-0768	jsimon@math.uiowa.edu	Topology, Low Dimensional Manifolds
Stewart, David	325B MLH	335-3832	dstewart@math.uiowa.edu	Numerical Analysis
Strohmer, Gerhard	B20G MLH	335-0721	strohmer@math.uiowa.edu	Partial Differential Equations, Fluid Dynamics
Stroyan, Keith	325M MLH	335-0789	keith-stroyan@uiowa.edu	Analysis
Ton-That, Tuong	25F MLH	335-0786	tonthat@math.uiowa.edu	Harmonic Analysis, Math Physics
Tymoczko, Julianna	225G MLH	335-0790	tymoczko@math.uiowa.edu	
Wang, Lihe	225B MLH	335-3253	lwang@math.uiowa.edu	Partial Differential Equations
Wu, Ying-Qing	B20H MLH	335-0793	wu@math.uiowa.edu	Topology
Ye, Yangbo	225F MLH	335-0717	yey@math.uiowa.edu	Representation Theory, Number Theory

WORKSHEET FOR PLANNING SCHEDULE

	Fall	Spring	Summer
Year 1	_____	_____	_____
	_____	_____	_____
	_____	_____	
	_____	_____	
	_____	_____	
Year 2	_____	_____	_____
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Year 3	_____	_____	_____
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Year 4	_____	_____	_____
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