

MICHIGAN STATE UNIVERSITY

February 22, 2012

MEMORANDUM

TO: Dr. Douglas Estry, Associate Provost for Undergraduate Education
and Dean of Undergraduate Studies

FROM: Dr. Linda O. Stanford, Associate Provost for Academic Services

RE: Request for a New Bachelor of Arts Degree in Mathematics, Advanced
For Transmittal to the University Committee on Undergraduate Studies
(UCUS)

The request referenced above is being sent to the University Committee on Undergraduate Studies (UCUS) in accordance with the *Bylaws for Academic Governance*, 4.4.

UCUS Response Requested:

Please ask the UCUS to consider the request referenced above and provide consultative commentary. Please mail the related materials referenced under the heading Attachments at the end of this memorandum to the UCUS members.

After receiving UCUS's consultative response, the Provost will make a determination to forward or not to forward the request to the University Committee on Curriculum for its approval of curriculum and degree requirements.

If you have any questions, please call Joy Speas, University Curriculum Administrator, at 5-8420.

Thank you.

Attachments:

1. Request to Establish a New Academic Program form dated January 9, 2012: Bachelor of Arts Degree in Mathematics, Advanced and attachments.

s:\share\ucusmthadvba



University Curriculum and Catalog

176 Administration Bldg.
East Lansing, MI
48824-1046

517-355-8420
Fax: 517-353-1935

View a Program		Main Menu
Joy Speas, RO	Monday, 1/9/2012	
Program Name: Mathematics, Advanced Degree: BA Sequence Number: 1	Program Request ID: 2041	
Effective Dates: Spring 2012 - Open Status: Interim Initial Action: New		
Requested Date: 7/13/2011 11:08:50 AM		
<p>1. Department/School/College: 32574 Department of Mathematics</p> <p>2. Name of Program: Mathematics, Advanced</p> <p>3. Name of Degree: BA</p> <p>4. Type of Program: Major <i>TE Secondary</i></p> <p>5. Effective Start Semester: <input checked="" type="checkbox"/> Fall <input type="checkbox"/> Spring 2012</p> <p>6. Target student audience for the program: Mathematically talented students interested in pursuing STEM careers</p> <p>7. Enrollment: What is the expected enrollment per year: 5 What is the minimum enrollment acceptable: 1</p> <p>8. Source of budget for the program: To align academic planning and curricular change, ALL requests for NEW funds must be included in the College's annual planning letter. Provost approval of new funds and the effective date for the new program must align. If funding is not approved, then the program request will not be forwarded to Faculty Senate. Internal reallocation If new funds, was this request included in the College's annual planning letter? Indicate yes or no. If no, then this is a department or college fund reallocation (If the program is implemented, no additional resources are required.).</p> <p>9. Projected Costs as compared to other programs in unit: Lower</p> <p>10. Staff requirement: How many additional staff will be required: 0 Who will provide the primary instruction. Describe any external linkages(industry, government, etc.):</p> <p>11. Will additional equipment be required:</p>		

Approximate cost: 0

Source of funding:

12. Will additional library materials be required:

Approximate cost: 0

Source of funding: No additional library materials will be required for this program.

13. Will additional space be required:

Type:

Approximate amount:

14. If the program requirements contain a named concentration, do you wish for the concentration to be noted on the student's transcript?:

No

15. Detailed Description:

15. Detailed Description:

Rationale: To address student requests for a BA, Advanced option. Currently there is only a BS, Advanced. In the Spring of 2011, the Bachelor of Science in Mathematics, Advanced was approved. A few students in the first group of students beginning this program strongly preferred the Bachelor of Arts over the Bachelor of Science degree. There are no mathematical differences between the two degrees; the BS requires 2 semesters of CEM, 2 semesters of PHY, first-year competency of foreign language; the BA requires 1 semester of CEM, 1 semester of PHY, and second-year competency of foreign language.

Sample Programs:

Here are two sample programs students could follow to obtain the Advanced Track degree. SAMPLE PROGRAM for students beginning in Linear Algebra for Bachelor of Arts.

	Fall	credits	Fall	Credits
Freshman Yr:	MTH 317H	3	MTH 254H	3
	WRA 1XX	4	FRN 102	4
	CEM 141	4	PHY 183	4
	FRN 101	4	IAH 201-210	4
Sophomore Yr:	MTH 327H	3	MTH 347H	3
	BS 161	3	MTH 429H	3
	BS 171	2	FRN 202	4
	ISS 2XX	4	IAH 211+	4
	FRN 201	4	MTH 291	1
Junior Yr:	MTH 418H	3	MTH 419H	3
	MTH 428H	3	MTH 496	3
	ISS 3XX	4	Electives	9

	Electives	4		
Senior Yr:	MTH4XX	3	MTH 4XX	3
	MTH 4XX	3	MTH 4XX	3
	Electives	9	Electives	9

SAMPLE PROGRAM for students beginning in Calculus II

	Fall	credits	Spring	Credits
Freshman Yr:	MTH 153H	3	MTH 317H	3
	WRA 1XX	4	FRN 102	4
	CEM 141	4	PHY 183	4
	FRN 101	4	IAH 201-210	4
Sophomore Yr:	MTH 254H	3	MTH327H	3
	MTH 418H	3	MTH 419H	3
	ISS 2XX	4	IAH 211+	4
	FRN 201	4	FRN 202	4
	Electives	1	MTH 291	1
Junior Yr:	MTH 4XX	3	MTH 347H	3
	MTH 428H	3	MTH 429H	3
	ISS 3XX	4	BS 161	3
	PHY 184	4	BS 171	2
	Electives	1	Electives	4
Senior Yr:	MTH496	3	MTH4XX	3
	MTH 4XX	3	MTH 4XX	3
	Electives	9	Electives	9

Michigan State University

Assessing Student Outcomes

College:

CNS

Department:

Mathematics

Program or Major:

BA with Distinction in Mathematics

Program Level:

Undergraduate

Contact Person:

Jeanne Wald, Associate Chair for the Undergraduate Program

Inventory of Written Statements and Plans

1. Do you have a written mission statement or statement of purpose? **yes**

If yes, please attach a copy or reference where this can be found:

The Advanced Track program is designed to provide high-level mathematical foundations for undergraduates headed toward STEM (science, technology, engineering, mathematics) careers.

2. Do you have a written statement of intended educational outcomes

describing what a student should know or be able to do when they have completed this program? **Yes (see above)**

3. Do you have a written method of assessment for measuring student outcomes? **no**

4. Does your program have a separate accreditation process? **no**
If yes, please list all accrediting agencies below:

Assessment Methodologies

It is likely that some assessment measures are already in place in this program even if they are not identified as being part of a formal assessment plan. Listed below are some of the assessment methodologies you may be using. Indicate "**A**" if the method is currently being used; "**B**" if it is **not** being used but you are interested in using it; and "**C**" if the method of assessment does not apply to your program.

Direct Methods of Assessment

1. C Comprehensive Examinations
2. C Writing proficiency Examinations
3. C National Examinations assessing subject matter knowledge
4. C Graduate Record Exam General Test
5. C Graduate Record Exam Subject Test
6. C Certification Examinations
7. C Licensure Examinations
8. C Locally developed pre-test or post-test for subject matter knowledge
9. C Senior thesis or major project
10. C Portfolio evaluation of student work
11. C Capstone courses
12. C Audio or Video tape evaluations

Indirect Methods of Assessment

1. C Comparison or benchmarking with peer institutions
2. B Job placement of graduates
3. C Employer surveys
4. C Advisory groups from your profession
5. B Graduate school acceptance rates
6. C Student graduation/retention rates
7. B Exit interviews with students graduating or leaving the program
8. B Student satisfaction surveys
9. B Student course evaluations
10. C Focus group discussions
11. B Alumni surveys
12. B Alumni honors, awards, achievements
13. C Analysis of grade distributions
14. C Peer review of courses
15. C Peer review of program
16. C Curriculum/syllabus analysis
17. C Community service/volunteerism participation
18. Other:

Does your program have an experiential learning component?

no

If yes, how do you assess the student learning outcomes from that experience?

1. Participate in a class designed to complement the experience
2. Student journals
3. Formal evaluation procedures from field-based supervisor
4. Formal meetings between supervisor, student, and faculty
5. Formal test of practical skills
6. Other:

Implementation Plans

1. How has your department used any of the indicators above to improve services and programs for students?
2. When you think about developing and implementing an assessment plan, what concerns do you have?

Return this form to: Kelly Funk

221 Administration Building

Assessing Student Outcomes modified and used with permission, Dr. Sharron L. Ronco,
Florida Atlantic University

CATALOG COPY

Part I

Academic Programs

College of Natural Science
Department of Mathematics
Yang Wang, Chairperson

Mathematics, which may partially be defined as the science of number and form, is a vital tool in all branches of knowledge the University covers, from accounting to zoology. Mathematics is also studied for its own sake by those who become fascinated by the results of modern mathematics and the making of new discoveries. The department offers a wide variety of courses that begin with extensions of high school mathematics and reach to the frontiers of mathematical knowledge.

Mathematics majors can build their programs in many different ways to pursue a career path of their choice. The department offers several Honors sequences, so that highly motivated mathematics students will find challenging programs. Students in mathematics, regardless of their major preferences, are encouraged to consult with the department before registration concerning the possibility of advanced placement or enrollment in honors sections.

Undergraduate Programs

The Mathematics Department offers several degree opportunities. These opportunities include a Bachelor of Science or Bachelor of Arts in Mathematics; a Bachelor of Science or Bachelor of Arts in Mathematics, Advanced; and Bachelor of Science or Bachelor of Arts in Computational Mathematics. The Bachelor of Science (or Arts) in Mathematics, Advanced degree is designed for all mathematically talented students who intend to pursue graduate studies or a profession in the mathematical sciences. While many of the courses in the Advanced Track program are Honors courses, students participating in this program are not required to be enrolled in the Honors College.

A Specialization in Actuarial Science is also available.

NOTE TO JOY: Please insert the BA in Mathematics, Advanced Track following the BS Mathematics, Advanced Track in the catalog

Mathematics - Bachelor of Arts in Mathematics, Advanced Track

The major is open to all mathematically talented students who seek a challenging program in

mathematics. While many courses are Honors courses, students pursuing this degree are not required to be in the Honors College. Students in this program are often eligible, as early as their junior year, to take graduate-level mathematics courses. (However, no graduate-level courses are required.) Upon completion, students are mathematically well prepared to enter top graduate schools or a rewarding career in the mathematical sciences.

Requirements for the Bachelor of Arts Degree in Mathematics , Advanced Track

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Mathematics.

The University's Tier II writing requirement for the Mathematics major is met by completing Mathematics 496 and Mathematics 418H. Those courses are referenced in items 3.c.(4) below.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading Graduation Requirements in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Arts degree. The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:
 - a. The following courses outside the Department of Mathematics (19 to 23 credits):
 - (1) One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
 - (2) One of the following courses (4 credits):

CEM 141	General Chemistry	4
CEM 151	General and Descriptive Chemistry	4
CEM 181H	Honors Chemistry I	4
LB 171	Principles of Chemistry	4
 - (3) One of the following courses (3-4 credits):

PHY 183	Physics for Scientists and Engineers I	4
PHY 193H	Honors Physics I - Mechanics	3
LB 273	Physics I	3 4
 - (4) One two credit laboratory course
 - (5) Second-year competency in a foreign language or
For students who have been admitted to the teacher certification program, completion of the Professional Education Courses in the Department of Teacher Education and first-year competency in a foreign language. These courses may be used to fulfill the requirements in (5).
 - (6) Six Credits from the College of Arts and Letters or the College of Social Science. → college req.
 - c. A total of 34-37 credits in courses in the Department of Mathematics including:
 - (1) One of the following courses (3-4 credits):

MTH 132	Calculus I	3
MTH 152H	Honors Calculus I	3
LB 118	Calculus I	4
 - (2) One of the following courses (3-4 credits):

MTH 133	Calculus II	4
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- | | | | |
|-----|---|---|---|
| | MTH 153H | Honors Calculus II | 3 |
| | LB 119 | Calculus II | 4 |
| (3) | One of the following courses (3-4 credits): | | |
| | MTH 234 | Multivariable Calculus | 4 |
| | MTH 254H | Honors Multivariable Calculus | 3 |
| | LB 220 | Calculus III | 4 |
| (4) | All of the following courses (25 credits): | | |
| | MTH 291 | Snapshots of Mathematics | 1 |
| | MTH 317H | Linear Algebra I, Advanced Track | 3 |
| | MTH 327H | Introduction to Analysis, Advanced Track | 3 |
| | MTH 347H | Ordinary Differential Equations, Adv. Track | 3 |
| | MTH 418H | Honors Algebra I | 3 |
| | MTH 419H | Honors Algebra II | 3 |
| | MTH 428H | Honors Analysis I | 3 |
| | MTH 429H | Honors Analysis II | 3 |
| | MTH 496 | Capstone in Mathematics | 3 |
- The completion of Mathematics 496 fulfills the department's capstone course requirement.
- d. A total of 12 credits in approved courses with substantive high-level quantitative material at the 400 level or above. Up to 9 of these 12 credits may be satisfied by courses in departments other than Mathematics.

16. Are there admissions requirements for this program?:

Grade or grade-point average requirements and if so in which course(s), portfolio requirement, audition, essay, etc. If there are not admission requirements other than those required by the University policy indicate "none".

none.

DEPARTMENT LEVEL APPROVAL STATUS

Approved: Department of Mathematics
1/5/2012 5:15:30 PM by Teri Roache for Yang Wang, Chairperson

COLLEGE LEVEL APPROVAL STATUS

Approved: College of Natural Science
1/9/2012 11:23:39 AM by Teri Roache for Kathryn M. Doig, Associate Dean

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COLLEGE OF NATURAL SCIENCE

1. Request to establish a **Bachelor of Arts** degree in **Mathematics, Advanced** in the Department of Mathematics. The University Committee on Undergraduate Studies (UCUS) will consider this request. The Teacher Education Council (TEC) will consider this request at its March 12, 2012 meeting.

- a. **Background Information:**

In Spring of 2010, the Bachelor of Science in Mathematics, Advanced was approved. During that semester, a few students interested in pursuing our new challenging program of mathematics, asked if there could be a Bachelor of Arts option for the program. Bachelor of Arts degree programs require a higher level of foreign language competency. This proposal addresses their request. What follows is the background leading up to the creation of the Bachelor of Science in Mathematics, Advanced.

In Fall 2009, the department formed an ad hoc committee consisting of four professors representing different research areas. The committee focused first on designing an advanced program in mathematics that would provide excellent quantitative preparation for talented undergraduates who may be seeking STEM (science, technology, engineering and mathematics) careers.

Currently the department offers only a few Honors courses. The Honors calculus courses are not designed specifically for students wanting to pursue advanced mathematics. After the Honors calculus sequence, there are only two year-long Honors courses offered. There is no coherent program designed to provide advanced mathematical foundations for students seriously interested in pursuing graduate or professional work in STEM areas.

The committee examined programs in mathematics departments at the Big Ten schools, as well as a sampling of other large and small universities in the United States. They also reviewed programs within the College of Natural Science. After careful consideration, a program proposal was created to submit to the Undergraduate Studies Committee in the department. The impact on the departmental teaching load was found to be minimal. Advanced sections of Linear Algebra already exist. The advanced course in Differential Equations (MTH 347H) will replace MTH 255H. There will be two additional courses: MTH 327H, an advanced introductory course in Analysis, and a 1-credit seminar sophomore-level course (MTH 291) designed to showcase mathematics. The two year-long senior-level Honors courses will be modified and incorporated into the advanced program. Mathematically strong Honors students will continue to be eligible to take these courses, as well as any of the other courses in this program.

Minimal efforts were made to recruit talented students into a newly created special advanced section of the existing linear algebra course. This advanced section was taught in both Fall and Spring Semesters of 2009-10 with enrollments between 10 and 15 students. More extensive recruitment occurred between February and July 2010. As of August 2010, over 60 entering freshmen enrolled in advanced sections of Calculus II and Linear Algebra, with the intention of continuing in subsequent advanced classes. These students scored in the 97th percentile on the mathematics portion of their ACT. More than two thirds scored in the 99th percentile. Clearly, there appears to be an MSU population for Advanced Mathematics. This program also addresses a nationwide need to offer a high quality program in mathematics intended for talented prospective STEM professionals.

Because many mathematics majors here at MSU are double-majors, this program is designed to interlock nicely with several undergraduate programs, most of which require a number of math courses included in this advanced degree program. For example, students interested in physics will be able to complete a double-major in physics and advanced mathematics in four years. Their earlier math courses are required for their physics degree; up to three highly mathematical senior-level or graduate-level physics courses count also as electives in the advanced mathematics degree requirements.

Recruitment will be the key to the success of this program. Recruiting will begin before the student enters MSU. The department will follow and improve the recruitment efforts by identifying students who are strong in mathematics, sending them invitations to join this program, providing information to other MSU advisors, and talking with talented students at Academic Orientation Programs during the summer. Additional recruitment efforts will be made at Alumni Distinguished Scholarship weekends.

b. **Academic Programs Catalog Text:**

The Bachelor of Arts Degree in Mathematics, Advanced is designed to prepare mathematically talented students for additional studies in prestigious graduate schools or to pursue rewarding careers in the mathematical sciences. While much of the course work is honors, students are not required to be a member of The Honors College. Students will often be eligible, as early as their junior year, to take graduate-level mathematics course work, although none is required for the degree.

Requirements for the Bachelor of Arts Degree in Advanced Mathematics

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Arts degree in Mathematics, Advanced.

The University's Tier II writing requirement for the Mathematics, Advanced major is met by completing Mathematics 418H and 496. Those courses are referenced in item 3. below.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Arts degree.

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

CREDITS

- a. The following courses outside the Department of Mathematics (12 or 13 credits):
- (1) One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
 - (2) One of the following courses (4 credits):

CEM	141	General Chemistry	4
CEM	151	General and Descriptive Chemistry	4
CEM	181H	Honors Chemistry I	4
LB	171	Principles of Chemistry I	4
 - (3) One of the following courses (3 or 4 credits):

PHY	183	Physics for Scientists and Engineers I	4
PHY	193H	Honors Physics I – Mechanics	3
LB	273	Physics I	4
 - (4) One 2 credit laboratory course.
- b. Second-year competency in a foreign language
or
For students who have been admitted to the teacher certification program, completion of the Professional Education Courses in the Department of Teacher Education and first-year competency in a foreign language.
- c. A total of 34 to 37 credits in courses in the Department of Mathematics including:
- (1) One of the following courses (3 or 4 credits):

MTH	132	Calculus I	3
MTH	152H	Honors Calculus I	3
LB	118	Calculus I	4
 - (2) One of the following courses (3 or 4 credits):

MTH	133	Calculus II	4
MTH	153H	Honors Calculus II	3
LB	119	Calculus II	4
 - (3) One of the following courses (3 or 4 credits):

MTH	234	Multivariable Calculus	4
MTH	254H	Honors Multivariable Calculus	3
LB	220	Calculus III	4
 - (4) All of the following courses (25 credits):

MTH	291	Mathematics Snapshots	1
MTH	317H	Advanced Linear Algebra	3
MTH	327H	Introduction to Advanced Analysis	3
MTH	347H	Advanced Ordinary Differential Equations	3
MTH	418H	Honors Algebra I	3

MTH	419H	Honors Algebra II	3
MTH	428H	Honors Analysis I	3
MTH	429H	Honors Analysis II	3
MTH	496	Capstone in Mathematics	3

The completion of Mathematics 496 fulfills the department's capstone course requirement.

- d. A total of 12 credits in approved courses with substantive high-level quantitative material at the 400-level or above. Up to 9 of these 12 credits may be satisfied by courses in departments other than Mathematics as approved by the student's academic advisor. Students in the teacher certification program must take Mathematics 432 to fulfill part of this elective requirement. Students in the teacher certification program must also take STT 430 which may *not* be counted as part of this requirement.

Effective Fall 2012.

DEPARTMENT of MATHEMATICS

Yang Wang, Chairperson

Mathematics, which may partially be defined as the science of number and form, is a vital tool in all branches of knowledge the university covers, from accounting to zoology. Mathematics is also studied for its own sake by those who become fascinated by the results of modern mathematics and the making of new discoveries. The department offers a wide variety of courses that begin with extensions of high school mathematics and reach to the frontiers of mathematical knowledge.

Mathematics majors can build their programs in many different ways to pursue a career path of their choice. The department offers several Honors sequences, so that highly motivated mathematics students will find challenging programs. Students in mathematics, regardless of their major preferences, are encouraged to consult with the department before registration concerning the possibility of advanced placement or enrollment in honors sections.

UNDERGRADUATE PROGRAMS

The Department of Mathematics offers several degree opportunities. These opportunities include a Bachelor of Arts or Bachelor of Science in Mathematics; a Bachelor of Science in Mathematics, Advanced; a Bachelor of Arts or Bachelor of Science in Computational Mathematics, and a Bachelor of Science in Actuarial Science.

The Bachelor of Science degree in Actuarial Science prepares students to work in insurance companies, banks, investment firms, government agencies, hospitals, and business firms where there is a need to weigh the financial consequences of risk. Course work is designed to provide the academic background for successful completion of five of the examinations of the Society of Actuaries (SOA): Exam P/1, Exam FM/2, Exams MLC/3 and MFE/3, and Exam C/4, including completion of the Validation by Educational Experience (VEE) course work in applied statistics, corporate finance, and economics. Completion of these SOA exams and VEE courses is required for those intending to become an Associate of the Society of Actuaries.

The Bachelor of Science Degree in Mathematics, Advanced is designed to prepare mathematically talented students for additional studies in top graduate schools or to pursue rewarding careers in the mathematical sciences and related fields. While much of the course work is honors, students are not required to be a member of The Honors College. Students will often be eligible, as early as their junior year, to take graduate-level mathematics course work, although none is required for the degree.

A Minor in Mathematics and a Specialization in Actuarial Science are also available.

Requirements for the Bachelor of Science Degree in Actuarial Science

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Actuarial Science.

The University's Tier II writing requirement for the Actuarial Science major is met by completing Mathematics 309 or 496. Those courses are referenced in item 3. below.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Science degree.

Bachelor of Arts or

Bachelor of Arts degree programs require a higher level of foreign language competency while Bachelor of Science degree program requirements require proficiency greater than the established minimum in the College.

Bachelor of Arts and

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

CREDITS

- a. One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
- b. One of the following groups of courses (8 or 10 credits):
 - (1) CEM 141 General Chemistry 4
 CEM 142 General and Inorganic Chemistry 3
 CEM 161 Chemistry Laboratory I 1
 - (2) CEM 151 General and Descriptive Chemistry 4
 CEM 152 Principles of Chemistry 3
 CEM 161 Chemistry Laboratory I 1
 - (3) CEM 181H Honors Chemistry I 4
 CEM 182H Honors Chemistry II 4
 CEM 185H Honors Chemistry Laboratory I 2
 - (4) LB 171 Principles of Chemistry I 4
 LB 171L Introductory Chemistry Laboratory I 1
 LB 172 Principles of Chemistry II 3
- c. One of the following groups of courses (6 or 8 credits):
 - (1) PHY 183 Physics for Scientists and Engineers I 4
 PHY 184 Physics for Scientists and Engineers II 4
 - (2) PHY 193H Honors Physics I – Mechanics 3
 PHY 294H Honors Physics II – Electromagnetism 3
 - (3) LB 271 Physics I 3
 LB 272 Physics II 3
- d. One of the following groups of courses (6 to 8 credits):
 - (1) MTH 132 Calculus I 3
 MTH 133 Calculus II 4
 - (2) LB 118 Calculus I 4
 LB 119 Calculus II 4
 - (3) MTH 152H Honors Calculus I 3
 MTH 153H Honors Calculus II 3
- e. One of the following courses (3 or 4 credits):
 - LB 220 Calculus III 4
 - MTH 234 Multivariable Calculus 4
 - MTH 254H Honors Multivariable Calculus 3
- f. One of the following courses (3 credits):
 - MTH 235 Differential Equations 3
 - MTH 255H Honors Differential Equations 3
 - MTH 340 Ordinary Differential Equations I 3
- g. One of the following courses (1 credit):
 - MTH 490 Directed Studies 1
 - MTH 491B Teamwork Experience 1
- h. All of the following courses (21 credits):
 - MTH 309 Linear Algebra I 3
 - MTH 360 Theory of Mathematical Interest 3
 - MTH 458 Financial Mathematics for Actuaries 3
 - STT 441 Probability and Statistics I: Probability 3
 - STT 455 Actuarial Models I 3
 - STT 456 Actuarial Models II 3
 - STT 459 Construction and Evaluation of Actuarial Models 3
- i. One of the following courses (3 credits):
 - MTH 457 Introduction to Financial Mathematics 3
 - STT 442 Probability and Statistics II: Statistics 3
- j. One of the following courses (3 credits):
 - MTH 491A Actuarial Internship 3
 - MTH 496 Capstone in Mathematics 3
- k. All of the following courses (18 credits):
 - ACC 230 Survey of Accounting Concepts 3
 - EC 201 Introduction to Microeconomics 3
 - EC 202 Introduction to Macroeconomics 3
 - FI 311 Financial Management 3
 - FI 321 Theory of Investments 3
 - FI 379 Financial Derivatives (D) 3
- l. One of the following courses (3 or 4 credits):
 - CSE 131 Technical Computing and Problem Solving 3
 - CSE 231 Introduction to Programming I 4

Requirements for the Bachelor of Science Degree in Computational Mathematics

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Computational Mathematics.

The University's Tier II writing requirement for the Computational Mathematics major is met by completing Mathematics 309 or 310 and 496. Those courses are referenced in item 3. c. (1) below.

Students who are in the teacher certification program are required to complete Mathematics 330 or 432 and Statistics and Probability 430.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements in the College* statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Science degree.

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

CREDITS

- a. The following courses outside the Department of Mathematics: . . . 27 or 29

- (1) One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
- (2) One of the following groups of courses (8 or 10 credits):
 - (a) CEM 141 General Chemistry 4
 CEM 142 General and Inorganic Chemistry 3
 CEM 161 Chemistry Laboratory I 1
 - (b) CEM 181H Honors Chemistry I 4
 CEM 182H Honors Chemistry II 4
 CEM 185H Honors Chemistry Laboratory I 2
- (3) Both of the following courses (8 credits):
 CSE 231 Introduction to Programming I 4
 CSE 232 Introduction to Programming II 4
- (4) Both of the following courses (8 credits):
 PHY 183 Physics for Scientists and Engineers I 4
 PHY 184 Physics for Scientists and Engineers II 4
- b. First-year competency in a foreign language
 or
 For students, who have been admitted to the teacher certification program, first-year competency in a foreign language and completion of the Professional Education Courses in the Department of Teacher Education.
- c. The following courses in the Department of Mathematics: 35
 - (1) All of the following courses (29 credits):
 - MTH 132 Calculus I 3
 - MTH 133 Calculus II 4
 - MTH 234 Multivariable Calculus 4
 - MTH 309 Linear Algebra I 3
 - MTH 310 Abstract Algebra I and Number Theory 3
 - MTH 320 Analysis I 3
 - MTH 451 Numerical Analysis I 3
 - MTH 481 Discrete Mathematics I 3
 - MTH 496 Capstone in Mathematics 3
 The completion of Mathematics 496 satisfies the capstone course requirement of the computational mathematics major.
 - (2) One of the following courses (3 credits):
 - MTH 452 Numerical Analysis II 3
 - MTH 482 Discrete Mathematics II 3
 - (3) One of the following courses (3 credits):
 - MTH 235 Differential Equations 3
 - MTH 340 Ordinary Differential Equations I 3
- d. At least one of the following courses: 3
 Students who select Mathematics 452 or 482 may count the credits toward either requirement 3.c.(2) or 3.d. but not toward both of those requirements.

Approval of the Department of Computer Science and Engineering is required to enroll in Computer Science and Engineering 331 and 440.

CSE 331	Algorithms and Data Structures	3
CSE 440	Introduction to Artificial Intelligence	3
MTH 360	Theory of Mathematical Interest	3
MTH 415	Applied Linear Algebra	3
MTH 416	Introduction to Algebraic Coding	3
MTH 441	Ordinary Differential Equations II	3
MTH 452	Numerical Analysis II	3
MTH 457	Introduction to Financial Mathematics	3
MTH 472	Mathematical Logic	3
MTH 482	Discrete Mathematics II	3
STT 351	Probability and Statistics for Engineering	3
STT 430	Introduction to Probability and Statistics	3
STT 441	Probability and Statistics I: Probability	3
STT 455	Actuarial Models	3
STT 461	Computations in Probability and Statistics	3

Requirements for the Bachelor of Arts Degree in Computational Mathematics

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Arts degree in Computational Mathematics.
 The University's Tier II writing requirement for the Computational Mathematics major is met by completing Mathematics 309 or 310 and 496. Those courses are referenced in item 3.c.(1) below.
 Students who are in the teacher certification program are required to complete Mathematics 330 or 432 and Statistics and Probability 430.
 Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.
2. The requirements of the College of Natural Science for the Bachelor of Arts degree.
 The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:

CREDITS

- a. The following courses outside the Department of Mathematics: 19
 - (1) One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
 - (2) The following course (4 credits):
 PHY 183 Physics for Scientists and Engineers I 4
 - (3) One of the following courses (4 credits):

	CEM 141 General Chemistry	4	
	CEM 181H Honors Chemistry I	4	
(4)	Both of the following courses (8 credits):		
	CSE 231 Introduction to Programming I	4	
	CSE 232 Introduction to Programming II	4	
b.	Second-year competency in a foreign language.		
	or		
	For students, who have been admitted to the teacher certification program, first-year competency in a foreign language and completion of the Professional Education Courses in the Department of Teacher Education.		
c.	The following courses in the Department of Mathematics:		35
(1)	All of the following courses (29 credits):		
	MTH 132 Calculus I	3	
	MTH 133 Calculus II	4	
	MTH 234 Multivariable Calculus	4	
	MTH 309 Linear Algebra I	3	
	MTH 310 Abstract Algebra I and Number Theory	3	
	MTH 320 Analysis I	3	
	MTH 451 Numerical Analysis I	3	
	MTH 481 Discrete Mathematics I	3	
	MTH 496 Capstone in Mathematics	3	
	The completion of Mathematics 496 satisfies the capstone course requirement of the computational mathematics major.		
(2)	One of the following courses (3 credits):		
	MTH 452 Numerical Analysis II	3	
	MTH 482 Discrete Mathematics II	3	
(3)	One of the following courses (3 credits):		
	MTH 235 Differential Equations	3	
	MTH 340 Ordinary Differential Equations I	3	
d.	At least one of the following courses:		3
	Students who select Mathematics 452 or 482 may count the credits toward either requirement 3.c.(2) or 3.d. but not toward both of those requirements.		
	Approval of the Department of Computer Science and Engineering is required to enroll in Computer Science and Engineering 331 and 440.		
	CSE 331 Algorithms and Data Structures	3	
	CSE 440 Introduction to Artificial Intelligence	3	
	MTH 360 Theory of Mathematical Interest	3	
	MTH 415 Applied Linear Algebra	3	
	MTH 416 Introduction to Algebraic Coding	3	
	MTH 441 Ordinary Differential Equations II	3	
	MTH 452 Numerical Analysis II	3	
	MTH 457 Introduction to Financial Mathematics	3	
	MTH 472 Mathematical Logic	3	
	MTH 482 Discrete Mathematics II	3	
	STT 351 Probability and Statistics for Engineering	3	
	STT 430 Introduction to Probability and Statistics	3	
	STT 441 Probability and Statistics I: Probability	3	
	STT 455 Actuarial Models	3	
	STT 461 Computations in Probability and Statistics	3	

Requirements for the Bachelor of Science Degree in Mathematics

- The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Mathematics.
 The University's Tier II writing requirement for the Mathematics major is met by completing Mathematics 396 or 496 and Mathematics 309 or 310 or 418H. Those courses are referenced in items 3.c.(1) and 3.c.(3) below.
 Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.
- The requirements of the College of Natural Science for the Bachelor of Science degree.
 The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
- The following requirements for the major:

CREDITS

a.	The following courses outside the Department of Mathematics: ..	19 to 21
(1)	One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.	
(2)	One of the following groups of courses (8 or 10 credits):	
(a)	CEM 141 General Chemistry	4
	CEM 142 General and Inorganic Chemistry	3
	CEM 161 Chemistry Laboratory I	1
(b)	CEM 181H Honors Chemistry I	4
	CEM 182H Honors Chemistry II	4
	CEM 185H Honors Chemistry Laboratory I	2
(3)	Both of the following courses (8 credits):	
	PHY 183 Physics for Scientists and Engineers I	4
	PHY 184 Physics for Scientists and Engineers II	4
b.	First-year competency in a foreign language	
	or	

For students who have been admitted to the teacher certification program, completion of the Professional Education Courses in the Department of Teacher Education.

- c. A total of 38 credits in courses in the Department of Mathematics including: 38
- (1) All of the following courses (17 credits):
- | | | |
|---------|-------------------------|---|
| MTH 132 | Calculus I | 3 |
| MTH 133 | Calculus II | 4 |
| MTH 234 | Multivariable Calculus | 4 |
| MTH 309 | Linear Algebra I | 3 |
| MTH 496 | Capstone in Mathematics | 3 |
- The completion of Mathematics 496 fulfills the department's capstone course requirement.
- Students in the teacher certification program substitute Mathematics 396 Capstone in Mathematics for Secondary Education for Mathematics 496.
- (2) A total of 24 credits in approved Mathematics courses at the 300 level or above. At least four of the approved Mathematics courses must be at the 400 level or above. Mathematics 415, 424, and 443 may not be used to fulfill the requirements of the major. The 300-400 level courses that are referenced in items 3.c. (1), 3.c. (3), 3.c. (4), and 3.c. (5) partially satisfy this requirement. Students may not use both Mathematics 309 and 314 to satisfy the requirement in 3.c.(2). One course from a list of approved cognates may be used to satisfy this requirement; the list is available in the Department of Mathematics. Statistics and Probability 430 is required for students in the teacher certification program. Either Statistics and Probability 430 or 441 may be substituted for one 300-level mathematics course.
- (3) One of the following groups of courses (6 credits):
- (a) MTH 310 Abstract Algebra I and
 Number Theory 3
 MTH 411 Abstract Algebra II 3
 Mathematics 414 or 417 or 418H or 481 may be substituted for Mathematics 411.
- (b) MTH 418H Honors Algebra I 3
 MTH 419H Honors Algebra II 3
- (4) One of the following pairs of courses (6 credits):
- (a) MTH 320 Analysis I 3
 MTH 421 Analysis II 3
 Mathematics 425 or 441 or 442 may be substituted for Mathematics 421.
- (b) MTH 428H Honors Analysis I 3
 MTH 429H Honors Analysis II 3
- (5) One of the following courses (3 credits):
- | | | |
|---------|-----------------------------------|---|
| MTH 330 | Higher Geometry | 3 |
| MTH 340 | Ordinary Differential Equations I | 3 |
| MTH 432 | Axiomatic Geometry | 3 |
- Students in the teacher certification program must take either Mathematics 330 or 432. Students not in the teacher certification program must take Mathematics 340. Students not in the teacher certification program with prior credit in Mathematics 235 or 255H may substitute an approved 400-level Mathematics course for Mathematics 340.

Requirements for the Bachelor of Arts Degree in Mathematics

- The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Arts degree in Mathematics.
 The University's Tier II writing requirement for the Mathematics major is met by completing Mathematics 396 or 496 and Mathematics 309 or 310 or 418H. Those courses are referenced in items 3. c. (1) and 3. c. (3) below.
 Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.
- The requirements of the College of Natural Science for the Bachelor of Arts degree.
 The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
- The following requirements for the major:

CREDITS

- a. The following courses outside the Department of Mathematics: 11
- One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
 - The following course (4 credits):
 PHY 183 Physics for Scientists and Engineers I 4
 - One of the following courses (4 credits):
 CEM 141 General Chemistry 4
 CEM 181H Honors Chemistry I 4
- b. Second-year competency in a foreign language
 or
 For students who have been admitted to the teacher certification program, first-year competency in a foreign language and completion of the Professional Education Courses in the Department of Teacher Education.
- c. A total of 38 credits in courses in the Department of Mathematics including: 38

- (1) All of the following courses (17 credits):
- | | | |
|---------|-------------------------|---|
| MTH 132 | Calculus I | 3 |
| MTH 133 | Calculus II | 4 |
| MTH 234 | Multivariable Calculus | 4 |
| MTH 309 | Linear Algebra I | 3 |
| MTH 496 | Capstone in Mathematics | 3 |
- The completion of Mathematics 496 fulfills the department's capstone course requirement.
 Students in the teacher certification program substitute Mathematics 396 Capstone in Mathematics for Secondary Education for Mathematics 496.
- (2) A total of 24 credits in approved Mathematics courses at the 300-level or above. At least 4 of the approved Mathematics courses must be at the 400-level or above. Mathematics 415, 424, and 443 may not be used to fulfill the requirements of the major. The 300-400 level courses that are referenced in items 3. c. (1), 3. c. (3), 3. c. (4) and 3. c. (5) partially satisfy this requirement. Students may not use both Mathematics 309 and 314 to satisfy the requirement in 3.c. (2). One course from a list of approved cognates may be used to satisfy this requirement; the list is available in the Department of Mathematics. Statistics and Probability 430 is required for students in the teacher certification program. Either Statistics and Probability 430 or 441 may be substituted for one 300-level mathematics course.
- (3) One of the following groups of courses (6 credits):
- (a) MTH 310 Abstract Algebra I and
 Number Theory 3
 MTH 411 Abstract Algebra II 3
 Mathematics 414 or 417 or 418H or 481 may be substituted for Mathematics 411.
- (b) MTH 418H Honors Algebra I 3
 MTH 419H Honors Algebra II 3
- (4) One of the following pairs of courses (6 credits):
- (a) MTH 320 Analysis I 3
 MTH 421 Analysis II 3
 Mathematics 425 or 441 or 442 may be substituted for Mathematics 421.
- (b) MTH 428H Honors Analysis I 3
 MTH 429H Honors Analysis II 3
- (5) One of the following courses (3 credits):
- | | | |
|---------|-----------------------------------|---|
| MTH 330 | Higher Geometry | 3 |
| MTH 340 | Ordinary Differential Equations I | 3 |
| MTH 432 | Axiomatic Geometry | 3 |
- Students in the teacher certification program must take either Mathematics 330 or 432. Students not in the teacher certification program must take Mathematics 340. Students not in the teacher certification program with prior credit in Mathematics 235 or 255H may substitute an approved 400-level Mathematics course for Mathematics 340.

Insert ①

Requirements for the Bachelor of Science Degree in Mathematics, Advanced

- The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Mathematics, Advanced.
 The University's Tier II writing requirement for the Mathematics, Advanced major is met by completing Mathematics 418H and 496. Those courses are referenced in item 3. below.
 Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.
- The requirements of the College of Natural Science for the Bachelor of Science degree.
 The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
- The following requirements for the major:

CREDITS

- a. The following courses outside the Department of Mathematics (17 to 21 credits):
- One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
 - One of the following groups of courses (8 or 10 credits):
 - CEM 141 General Chemistry 4
 CEM 142 General and Inorganic Chemistry 3
 CEM 161 Chemistry Laboratory I 1
 - CEM 151 General and Descriptive Chemistry 4
 CEM 152 Principles of Chemistry 3
 CEM 161 Chemistry Laboratory I 1
 - CEM 181H Honors Chemistry I 4
 CEM 182H Honors Chemistry II 4
 CEM 185H Honors Chemistry Laboratory I 2
 - LB 171 Principles of Chemistry I 4
 LB 172 Principles of Chemistry II 3
 LB 171L Introductory Chemistry Laboratory I 1
 - One of the following groups of courses (6 or 8 credits):
 - PHY 183 Physics for Scientists and Engineers I . 4
 PHY 184 Physics for Scientists and Engineers II . 4

Requirements for the Bachelor of Arts Degree in Advanced Mathematics

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Arts degree in Mathematics, Advanced.

The University's Tier II writing requirement for the Mathematics, Advanced major is met by completing Mathematics 418H and 496. Those courses are referenced in item 3. below.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading *Graduation Requirements* in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Arts degree.

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

CREDITS

- a. The following courses outside the Department of Mathematics (12 or 13 credits):
 - (1) One course of at least 3 credits in biological science, entomology, microbiology, physiology, plant biology, or zoology.
 - (2) One of the following courses (4 credits):

	CEM 141	General Chemistry	4
	CEM 151	General and Descriptive Chemistry	4
	CEM 181H	Honors Chemistry I	4
	LB 171	Principles of Chemistry I	4
 - (3) One of the following courses (3 or 4 credits):

	PHY 183	Physics for Scientists and Engineers I	4
	PHY 193H	Honors Physics I – Mechanics	3
	LB 273	Physics I	4
 - (4) One 2 credit laboratory course.
- b. Second-year competency in a foreign language
or
For students who have been admitted to the teacher certification program, completion of the Professional Education Courses in the Department of Teacher Education and first-year competency in a foreign language.
- c. A total of 34 to 37 credits in courses in the Department of Mathematics including:
 - (1) One of the following courses (3 or 4 credits):

	MTH 132	Calculus I	3
	MTH 152H	Honors Calculus I	3
	LB 118	Calculus I	4
 - (2) One of the following courses (3 or 4 credits):

	MTH 133	Calculus II	4
	MTH 153H	Honors Calculus II	3
	LB 119	Calculus II	4
 - (3) One of the following courses (3 or 4 credits):

	MTH 234	Multivariable Calculus	4
	MTH 254H	Honors Multivariable Calculus	3
	LB 220	Calculus III	4
 - (4) All of the following courses (25 credits):

	MTH 291	Mathematics Snapshots	1
	MTH 317H	Advanced Linear Algebra	3
	MTH 327H	Introduction to Advanced Analysis	3

MTH	347H	Advanced Ordinary Differential Equations	3
MTH	418H	Honors Algebra I	3
MTH	419H	Honors Algebra II	3
MTH	428H	Honors Analysis I	3
MTH	429H	Honors Analysis II	3
MTH	496	Capstone in Mathematics	3

The completion of Mathematics 496 fulfills the department's capstone course requirement.

- d. A total of 12 credits in approved courses with substantive high-level quantitative material at the 400-level or above. Up to 9 of these 12 credits may be satisfied by courses in departments other than Mathematics as approved by the student's academic advisor. Students in the teacher certification program must take Mathematics 432 to fulfill part of this elective requirement. Students in the teacher certification program must also take STT 430 which may *not* be counted as part of this requirement.

- (b) PHY 193H Honors Physics I – Mechanics 3
- PHY 294H Honors Physics II – Electromagnetism 3
- (c) LB 271 Physics I 3
- LB 272 Physics II 3
- b. First-year competency in a foreign language
- or
- For students who have been admitted to the teacher certification program, completion of the Professional Education Courses in the Department of Teacher Education.
- c. A total of 34 to 37 credits in courses in the Department of Mathematics including:
 - (1) One of the following courses (3 or 4 credits):
 - MTH 132 Calculus I 3
 - MTH 152H Honors Calculus I 3
 - LB 118 Calculus I 4
 - (2) One of the following courses (3 or 4 credits):
 - MTH 133 Calculus II 4
 - MTH 153H Honors Calculus II 3
 - LB 119 Calculus II 4
 - (3) One of the following courses (3 or 4 credits):
 - MTH 234 Multivariable Calculus 4
 - MTH 254H Honors Multivariable Calculus 3
 - LB 220 Calculus III 4
 - (4) All of the following courses (25 credits):
 - MTH 291 Mathematics Snapshots 1
 - MTH 317H Advanced Linear Algebra 3
 - MTH 327H Introduction to Advanced Analysis 3
 - MTH 347H Advanced Ordinary Differential Equations 3
 - MTH 418H Honors Algebra I 3
 - MTH 419H Honors Algebra II 3
 - MTH 426H Honors Analysis I 3
 - MTH 429H Honors Analysis II 3
 - MTH 496 Capstone in Mathematics 3
 The completion of Mathematics 496 fulfills the department's capstone course requirement.
- d. A total of 12 credits in approved courses with substantive high-level quantitative material at the 400-level or above. Up to 9 of these 12 credits may be satisfied by courses in departments other than Mathematics as approved by the student's academic advisor. Students in the teacher certification program must take Mathematics 432 to fulfill part of this elective requirement. Students in the teacher certification program must also take STT 430 which may not be counted as part of this requirement.

MINOR IN MATHEMATICS

The Minor in Mathematics, which is administered by the Department of Mathematics, will broaden students' understanding and application of mathematical concepts to their chosen field of study.

The minor is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University other than the Bachelor of Arts and Bachelor of Science Degree in Mathematics. With the approval of the department and college that administer the student's degree program, the courses that are used to satisfy the minor may also be used to satisfy the requirements for the bachelor's degree. At least 12 unique credits counted towards the requirements for a student's minor must not be used to fulfill the requirements for that student's major.

Students who plan to complete the requirements of the minor should consult the undergraduate advisor in the Department of Mathematics.

Requirements for the Minor in Mathematics

	CREDITS
Complete the following (21 to 24 credits):	
1. One of the following courses (3 or 4 credits):	
LB 118 Calculus I	4
MTH 132 Calculus I	3
MTH 152H Honors Calculus I	3
2. One of the following courses (3 or 4 credits):	
LB 119 Calculus II	4
MTH 133 Calculus II	4
MTH 153H Honors Calculus II	3
3. One of the following courses (3 or 4 credits):	
LB 220 Calculus III	4
MTH 234 Multivariable Calculus	4
MTH 254H Honors Multivariable Calculus	3
4. All of the following courses (12 credits):	
MTH 309 Linear Algebra I	3
MTH 310 Abstract Algebra I and Number Theory	3
MTH 320 Analysis I	3
One 400-level mathematics course	3

SPECIALIZATION IN ACTUARIAL SCIENCE

The Specialization in Actuarial Science, which is administered by the Department of Mathematics within the College of Natural Science, is available as an elective to students who are enrolled in any bachelor's degree program at Michigan State University. This specialization complements a number of major fields such as mathematics, statistics and probability, finance, and economics. It is intended to prepare students for work in insurance companies, banks, investment firms, government work, hospitals and business firms where there is a need to weigh the financial consequences of risk. The Specialization in Actuarial Science prepares students for two of the examinations of the Society of Actuaries (SOA): Exam P/1 and Exam FM/2. With the approval of the department that administers the student's degree program, courses that are used to satisfy the requirements for the specialization may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Specialization in Actuarial Science

The student must complete all of the following courses (21 credits):

	CREDITS
1. All of the following courses (18 credits):	
FI 311 Financial Management	3
FI 321 Theory of Investments	3
FI 379 Advanced Derivatives (D)	3
MTH 360 Theory of Mathematical Interest	3
STT 441 Probability and Statistics I: Probability	3
STT 455 Actuarial Models	3
2. One of the following courses (3 credits):	
MTH 457 Introduction to Financial Mathematics	3
STT 442 Probability and Statistics II: Statistics	3

Upon completion of the requirements for the Specialization in Actuarial Science, the students should contact the Chairperson of the Department of Mathematics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Mathematics and the Associate Dean of the College of Natural Science, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

TEACHER CERTIFICATION OPTIONS

The mathematics disciplinary majors leading to the Bachelor of Arts and Bachelor of Science degrees are available for teacher certification. The mathematics, advanced major leading to the Bachelor of Science degree is also available for secondary teacher certification.

— Bachelor of Arts or

A mathematics-elementary and mathematics-secondary disciplinary minor are also available for teacher certification.

Students who elect a mathematics or mathematics, advanced disciplinary major or the mathematics-elementary or mathematics-secondary disciplinary minor must contact the Department of Mathematics.

For additional information, refer to the statement on *TEACHER CERTIFICATION* in the *Department of Teacher Education* section of this catalog.

**OPTIONS FOR ACCEPTABLE SUBJECT MATTER
 TEACHING MAJORS AND MINORS FOR SECONDARY
 TEACHER CERTIFICATION**

**Disciplinary Majors Available for Secondary Teacher
 Certification**

MAJOR	COLLEGE
Arabic	Arts and Letters
Biological Science-Interdepartmental	Natural Science
Chemistry	Natural Science
Chinese	Arts and Letters
Comparative Cultures and Politics	James Madison College
Earth Science-interdepartmental	Natural Science
English	Arts and Letters
Environmental Studies and Agriscience	Agriculture and Natural Resources
French	Arts and Letters
German	Arts and Letters
History	Social Science
Interdisciplinary Studies in Social Science: Social Science Education	Social Science
International Relations	James Madison College
Japanese	Arts and Letters
Journalism	Communication Arts and Sciences
Mathematics	Natural Science
Mathematics, Advanced	Natural Science
Physical Science-Interdepartmental	Natural Science
Physics	Natural Science
Political Theory and Constitutional Democracy	James Madison College
Social Relations and Policy	James Madison College
Spanish	Arts and Letters

← already listed for BS

**Disciplinary Teaching Minors Available for Secondary
 Teacher Certification**

MINOR	COLLEGE
Agriscience	Agriculture and Natural Resources
Arabic	Arts and Letters
Biological Science	Natural Science
Chemistry	Natural Science
Chinese	Arts and Letters
Computer Science	Engineering
Earth Science	Natural Science
Economics	Social Science
English	Arts and Letters
French	Arts and Letters
Geography	Social Science
German	Arts and Letters
History	Social Science
Italian	Arts and Letters
Japanese	Arts and Letters
Journalism	Communication Arts and Sciences
Latin	Arts and Letters
Mathematics-Secondary	Natural Science
Physics	Natural Science
Political Science	Social Science
Psychology	Social Science
Russian	Arts and Letters
Sociology	Social Science
Spanish-Secondary	Arts and Letters
Teaching English to Speakers of Other Languages	Arts and Letters

The economics disciplinary teaching minor is available only to students pursuing a major in comparative cultures and politics, international relations, political theory and constitutional democracy, social relations and policy, interdisciplinary studies in social science, interdisciplinary studies in social science: social science education, or history with a teacher certification option.

**Undergraduate Majors Leading to K-12 Endorsements on
 a Secondary Teacher Certificate**

MAJOR	COLLEGE
Arabic	Arts and Letters
Art Education	Arts and Letters
Chinese	Arts and Letters
Communicative Sciences and Disorders	Communication Arts and Sciences
Music Education	Arts and Letters

Environmental studies and agriscience is a group major requiring 36 or more semester credits.

Art education, comparative cultures and politics, interdisciplinary studies in social science: social science education, international relations, music education, physical science - interdepartmental, political theory and constitutional democracy,

and social relations are comprehensive group majors requiring a minimum of 50 semester credits, and are exempt from the requirement to complete a separate teaching minor.

A given course may not be counted toward the credit requirements for both a disciplinary major and a disciplinary minor. Courses for an optional extra teaching minor or major may be double-counted.