

MICHIGAN STATE UNIVERSITY

February 10, 2023

MEMORANDUM

TO: Dr. Mark Largent, Associate Provost for Undergraduate Education
and Dean of Undergraduate Studies

FROM: Joy Speas, University Curriculum Administrator

RE: Request for a New Bachelor of Science Degree in Integrated Science-
Secondary Education

For Transmittal to the University Committee on Undergraduate
Education (UCUE)

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

UCUE Response Requested:

Please ask the committee 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 committee members.

After receiving the committee'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 me at 5-8420.

Thank you.

Attachments:

1. Request to Establish a New Academic Program form dated February 3, 2023: Bachelor of Science Degree in Integrated Science-Secondary Education and attachments.



University Curriculum and Catalog

Hannah Admin. Building
426 Auditorium Road
Suite 430
East Lansing, MI 48824

517-355-8420
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COLLEGE OF NATURAL SCIENCE

1. Request to establish a **Bachelor of Science** degree in **Integrated Science-Secondary Education** in the College of Natural Science. The University Committee on Undergraduate Education (UCUE) will consider this request at its February 16, 2023 meeting.

The concentrations in the Bachelor of Science degree in Integrated Science-Secondary Education are noted on the student's academic record when the requirements for the degree have been completed.

a. **Background Information:**

A new undergraduate degree program is required to meet the new Standards for the Preparation of High School (7-12) Science Teachers approved by the Michigan Department of Education in February 2022 (https://www.michigan.gov/mde/-/media/Project/Websites/mde/educator_services/prep/standards/HS_Science_Teacher_Preparation_Standards.pdf?rev=cc6a0c7226b94c78a81b47ff2f69122&hash=398961EB0190C07472D28B34664A7232).

Going forward, all candidates seeking certification to teach science at the secondary level in Michigan must complete a degree program aligned with the new standards, which will prepare them to teach life science (biology), chemistry, earth and space science, and physics. The Integrated Science-Secondary Education degree program will replace the four existing science subject matter teaching majors for secondary teaching certification: Biological Science-Secondary Education, Chemistry, Physical Science-Secondary Education, and Physics.

Public education in the State of Michigan and across the country is facing a significant shortage of qualified science teachers. Through collaboration, MSU's College of Natural Science and the College of Education Teacher Preparation Program have a strong history of training highly qualified science teachers. This new program was developed in response to two significant policy changes to allow MSU to continue training high school science teachers. In February 2022, the Michigan Department of Education approved new standards for secondary science teachers (grades 7-12) that require all new science teachers to have the disciplinary content knowledge to teach subjects across the natural sciences (life science, chemistry, earth and space science, and physics). None of NatSci's existing teaching majors are fully aligned with the new standards. At the same time, MSU's Teacher Preparation Program made the decision to shorten the program length from five years to four years to reduce the costs associated with preparing to become a teacher and to get new teachers into the classroom sooner. This new program will allow MSU to continue its success in preparing highly qualified high school science teachers.

Development of strong science content knowledge is essential to preparing teacher candidates to teach science at the secondary level. Students in this degree program will build disciplinary science content knowledge in courses offered by units in the College of Natural Science. The College of Natural Science will administer and provide academic advising to support the Integrated Science-Secondary Education major. The Dean's Office currently provides oversight for the existing interdisciplinary science teaching majors (Biological Science-Secondary Education and Physical Science-Secondary Education), which will be replaced by the new major.

The educational objective of this program is to support future science teachers in 1) building foundational science content knowledge and 2) developing the elements of effective teaching practice so that they can become highly effective high school science teachers who equitably serve diverse student populations.

Preparing the next generation of high school science teachers is a priority for the College of Natural Science and the College of Education. The two colleges are committed to collaborating in this effort. Increasing the number of well-qualified high school science teachers is critical to preparing Michigan's students for higher education and other post-secondary training to meet Michigan's workforce needs.

b. **Academic Programs Catalog Text:**

The Bachelor of Science Degree in Integrated Science-Secondary Education is designed for persons who want a broad background in biology, chemistry, earth and space science, and physics and to understand the interrelationships between these disciplines. This major is designed primarily for persons who plan to teach science (life science, chemistry, earth and space science, or physics) in secondary schools.

Requirements for the Bachelor of Science Degree in Integrated Science-Secondary Education

- | | | | | CREDITS |
|----|--|---|---|---------|
| 1. | The University requirements for bachelor's degrees as described in the <i>Undergraduate Education</i> section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Integrated Science-Secondary Education. | | | |
| | The University's Tier II writing requirement for the Integrated Science-Secondary Education major is met by completing Integrated Science Education 401. That course is 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 <i>Graduation Requirements in the College</i> statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track. | | | |
| | Students may substitute Teacher Education 101 and 102 for two ISS requirements. | | | |
| | Students may substitute Teacher Education 341 for the first-level IAH requirement (courses numbered 201 through 210). Those courses are referenced in item 3. below. | | | |
| 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: | | | |
| | a. | One of the following groups of courses (9 or 10 credits): | | |
| | | (1) | BS 161 Cell and Molecular Biology | 3 |
| | | | BS 162 Organismal and Population Biology | 3 |
| | | | BS 171 Cell and Molecular Biology Laboratory | 2 |
| | | | BS 172 Organismal and Population Biology Laboratory | 2 |
| | | (2) | BS 181H Honors Cell and Molecular Biology | 3 |
| | | | BS 182H Honors Organismal and Population Biology | 3 |
| | | | BS 191H Honors Cell and Molecular Biology Laboratory | 2 |
| | | | BS 192H Honors Organismal and Population Biology Laboratory | 2 |
| | | (3) | LB 144 Biology I: Organismal Biology | 4 |
| | | | LB 145 Biology II: Cellular and Molecular Biology | 5 |
| | b. | One of the following groups of courses (9 or 10 credits): | | |
| | | (1) | CEM 141 General Chemistry | 4 |
| | | | CEM 142 General and Inorganic Chemistry | 3 |
| | | | CEM 161 Chemistry Laboratory I | 1 |
| | | | CEM 162 Chemistry Laboratory II | 1 |
| | | (2) | CEM 151 General and Descriptive Chemistry | 4 |
| | | | CEM 152 Principles of Chemistry | 3 |
| | | | CEM 161 Chemistry Laboratory I | 1 |
| | | | CEM 162 Chemistry Laboratory II | 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 |
| | | | LB 172L Principles of Chemistry II-Reactivity Laboratory | 1 |
| | c. | One of the following groups of courses (8 or 10 credits): | | |
| | | (1) | PHY 173 Studio Physics for Scientists and | |

			Engineers I	5
	PHY	174	Studio Physics for Scientists and Engineers II	5
(2)	PHY	183	Physics for Scientists and Engineers I	4
	PHY	184	Physics for Scientists and Engineers II	4
	PHY	191	Physics Laboratory for Scientists, I	1
	PHY	192	Physics Laboratory for Scientists, II	1
(3)	PHY	221	Studio Physics for Life Scientists I	4
	PHY	222	Studio Physics for Life Scientists II	4
(4)	PHY	231	Introductory Physics I	3
	PHY	232	Introductory Physics II	3
	PHY	251	Introductory Physics Laboratory I	1
	PHY	252	Introductory Physics Laboratory II	1
(5)	LB	273	Physics I	4
	LB	274	Physics II	4
d.	All of the following courses (14 credits):			
	IBIO	355	Ecology	3
	ISE	322	Foundational Earth Systems for Secondary Science Education	4
	ISE	401	Science Laboratories for Secondary Schools (W)	4
	ISE	420	Integrated Science Research	3
e.	The following Professional Education Courses in the College of Education (36 credits):			
(1)	All of the following courses from the shared professional sequence (18 credits):			
	CEP	240	Diverse Learners in Multicultural Perspective	3
	TE	101	Social Foundations of Justice and Equity in Education	3
	TE	102	Pedagogy and Politics of Justice and Equity in Education	3
	TE	150	Reflections on Learning	3
	TE	302	Literacy and Adolescent Learners in School and Community Contexts	3
	TE	341	Teaching and Learning of (Bi)Multilingual Learners	3
(2)	All of the following courses from the subject-specific professional sequence (18 credits):			
	TE	321	Clinical Experience in Science Education I	3
	TE	421	Clinical Experience in Science Education II	3
	TE	422	Seminar in Science Education I	3
	TE	423	Seminar in Science Education II	3
	TE	424	Student Teaching Internship in Science Education	6
f.	One of the following concentrations:			
	Biology			
(1)	One course from group (a) and one course from group (b) (6 to 8 credits):			
(a)	MTH	124	Survey of Calculus I	3
	MTH	132	Calculus I	3
	MTH	152H	Honors Calculus I	3
	LB	118	Calculus I	4
(b)	MTH	126	Survey of Calculus II	3
	MTH	133	Calculus II	4
	MTH	153H	Honors Calculus II	3
	LB	119	Calculus II	4
	STT	201	Statistical Methods	4
	STT	231	Statistics for Scientists	3
	STT	351	Probability and Statistics for Engineering	3
	STT	421	Statistics I	3
(2)	One of the following groups of courses (3 or 6 credits):			
(a)	CEM	144	Organic Chemistry and Applications	3

	(b)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(c)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	All of the following courses (7 credits):				
	IBIO	341		Fundamental Genetics	4
	IBIO	355L		Ecology Laboratory (W)	1
	IBIO	445		Evolution (W)	3
(4)	One of the following courses (3 or 4 credits)				
	BMB	401		Comprehensive Biochemistry	4
	FW	417		Wetland Ecology and Management	3
	IBIO	408		Histology	4
	IBIO	425		Cells and Development (W)	4
	MMG	301		Introductory Microbiology	3
	NEU	300		Neurobiology	3
	PLB	415		Plant Physiology	3
	PLB	418		Plant Systematics	3
	PLB	441		Plant Ecology	3
	PSL	250		Introductory Physiology	4
	PSL	310		Physiology for Pre-Health Professionals	4

Chemistry

(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
	(a)	MTH	132	Calculus I	3
		MTH	152H	Honors Calculus I	3
		LB	118	Calculus I	4
	(b)	MTH	133	Calculus II	4
		MTH	153H	Honors Calculus II	3
		LB	119	Calculus II	4
(2)	One of the following groups of courses (6 credits):				
	(a)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(b)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	All of the following courses (9 credits):				
	CEM	255		Organic Chemistry Laboratory	2
	CEM	262		Quantitative Analysis	3
	CEM	383		Introductory Physical Chemistry I	3
	CEM	444		Chemical Safety	1
(4)	One of the following courses (3 or 4 credits):				
	BMB	401		Comprehensive Biochemistry	4
	CEM	311		Inorganic Chemistry	3
	CEM	384		Introductory Physical Chemistry II	3

Physics

(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
	(a)	MTH	132	Calculus I	3
		MTH	152H	Honors Calculus I	3
		LB	118	Calculus I	4
	(b)	MTH	133	Calculus II	4
		MTH	153H	Honors Calculus II	3
		LB	119	Calculus II	4
(2)	One of the following groups of courses (3 or 6 credits):				
	(a)	CEM	144	Organic Chemistry and Applications	3
	(b)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(c)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	All of the following courses (14 credits):				
	CMSE	201		Computational Modeling and Data Analysis I	4
	MTH	234		Multivariable Calculus	4
	MTH	235		Differential Equations	3

	PHY	215	Thermodynamics and Modern Physics	3
(4)	One of the following courses (3 or 4 credits):			
	PHY	321	Classical Mechanics I	3
	PHY	431	Optics I	3
	PHY	440	Electronics	4
	PHY	481	Electricity and Magnetism I	3

Earth Science

(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
	(a)	MTH	124	Survey of Calculus I	3
		MTH	132	Calculus I	3
		MTH	152H	Honors Calculus I	3
		LB	118	Calculus I	4
	(b)	MTH	126	Survey of Calculus II	3
		MTH	133	Calculus II	4
		MTH	153H	Honors Calculus II	3
		LB	119	Calculus II	4
		STT	201	Statistical Methods	4
		STT	231	Statistics for Scientists	3
		STT	351	Probability and Statistics for Engineering	3
		STT	421	Statistics I	3
(2)	One of the following groups of courses (3 or 6 credits):				
	(a)	CEM	144	Organic Chemistry and Applications	3
	(b)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(c)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	The following course (4 credits):				
	GLG	201	The Dynamic Earth	4	
(4)	Two of the following courses (6 to 8 credits):				
	GLG	303	Oceanography	3	
	GLG	304	Physical and Biological History of the Earth	4	
	GLG	321	Mineralogy and Geochemistry	4	
	GLG	361	Igneous and Metamorphic Geochemistry and Petrology	4	
	GLG	401	Global Tectonics and Earth Structure (W)	4	
	GLG	411	Hydrogeology	3	
	GLG	412	Glacial Geology and the Record of Climate Change	4	
	GLG	421	Environmental Geochemistry	4	
	GLG	435	Geomicrobiology	4	
	GLG	440	Planetary Geology	3	

Effective Fall 2023.



View a Program

Joy Speas, Office of the Registrar

Tuesday, 2/7/2023

Program Name: Integrated Science-
Secondary Education
Degree: BS Sequence Number: 1

Program Request ID: 4933

Effective Dates: Fall 2023 - Open

Status: Interim

Initial Action: New

Requested Date: 1/7/2023 6:15:09 PM

1. Department/School/College:

10032604 College of Natural Science

2. Name of Program:

Integrated Science-Secondary Education

3. Name of Degree:

BS

4. Type of Program:

Major

5. Effective Start Semester:

Fall 2023

6. Target student audience for the program:

Undergraduate students planning to teach science in grades 7-12

7. Enrollment:

What is the expected enrollment per year: 20

What is the minimum enrollment acceptable: 5

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.

New Funds

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.).

The Center for Integrative Studies in General Science has requested funding from the College of Education to support offering a new course (ISE 322) required for the four-year Integrated Science-Secondary Education degree program. The additional funding is required because capacity in ISP/ISB (150-200 seats) will be lost when an instructor teaches this new course instead of a section of ISB or ISP.

9. Projected Costs as compared to other programs in unit:

Same

10. Staff requirement:

How many additional staff will be required: 0

Who will provide the primary instruction. Describe any external linkages(industry, government, etc.):

ISE Courses: Matthew Oney (CISGS), Robert Drost (CISGS) Science Content Courses: Faculty from the following NatSci departments and programs: Biochemistry and Molecular Biology, Biological Sciences, Chemistry, Earth and Environmental Sciences, Integrative Biology, Mathematics, Microbiology and Molecular Genetics, Physics and Astronomy, Physiology, Plant Biology, Statistics and Probability Professional Education Courses: Faculty from the Department of Teacher Education

11. Will additional equipment be required:

Approximate cost: 0

Source of funding:

12. Will additional library materials be required:

Approximate cost: 0

Source of funding:

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?:

Yes

15. Detailed Description:

a. Background information including the considerations which precipitated the development of the program, and its relationship to similar programs offered at MSU and by other educational institutions. Supply a copy of standards of accrediting agencies and federal regulations related to the request as appropriate.

A new undergraduate degree program is required to meet the new *Standards for the Preparation of High School (7-12) Science Teachers* approved by the Michigan Department of Education in February 2022.

https://www.michigan.gov/mde/-/media/Project/Websites/mde/educator_services/rep/standards/HS_Science_Teacher_Preparation_Standards.pdf?rev=cc6a0c7226b94c78a81b47fff2f69122&hash=398961EB0190C07472D28B34664A7232
(https://www.michigan.gov/mde/-/media/Project/Websites/mde/educator_services/rep/standards/HS_Science_Teacher_Preparation_Standards.pdf?rev=cc6a0c7226b94c78a81b47fff2f69122&hash=398961EB0190C07472D28B34664A7232)

Going forward, all candidates seeking certification to teach science at the secondary level in Michigan must complete a degree program aligned with the new standards, which will prepare them to teach life science (biology), chemistry, earth and space science, and physics. The Integrated Science-Secondary Education degree program will replace the four existing science subject matter teaching majors for secondary teaching certification: Biological Science-Secondary Education, Chemistry, Physical Science-Secondary Education, and Physics.

b. Rationale for offering the program at MSU.

Public education in the State of Michigan and across the country is facing a significant shortage of qualified science teachers. Through collaboration, MSU's College of Natural Science and the College of Education Teacher Preparation Program have a strong history of training highly qualified science teachers. This new program was developed in response to two significant policy changes to allow MSU to continue training high school science teachers. In February 2022, the Michigan Department of Education approved new standards for secondary science teachers (grades 7-12) that require all new science teachers to have the disciplinary content knowledge to teach subjects across the natural sciences (life science, chemistry, earth and space science, and physics). None of NatSci's existing teaching majors is fully aligned with the new standards. At the same time, MSU's Teacher Preparation Program made the decision to shorten the program length from five years to four years to reduce the costs associated with preparing to become a teacher and to get new teachers into the classroom sooner. This new program will allow MSU to continue its success in preparing highly qualified high school science teachers.

c. Rationale for the program being housed in the primary administrative unit.

Development of strong science content knowledge is essential to preparing teacher candidates to teach science at the secondary level. Students in this degree program will build disciplinary science content knowledge in courses offered by units in the College of Natural Science. As such, it makes sense for NatSci to administer and provide academic advising to support the Integrated Science-Secondary Education major. The Dean's Office currently provides oversight for the existing interdisciplinary science teaching majors (Biological Science-Secondary Education and Physical Science-Secondary Education), which will be replaced by the new major.

d. Educational objectives of the program and their relationship to those of the college and the University.

The educational objective of this program is to support future science teachers in 1) building foundational science content knowledge and 2) developing the elements of effective teaching practice so that they can become highly effective high school science teachers who equitably serve diverse student populations.

Preparing the next generation of high school science teachers is a priority for the College of Natural Science and the College of Education. The two colleges are committed to collaborating in this effort. Increasing the number of well-qualified high school science teachers is critical to preparing Michigan's students for higher education and other post-secondary training to meet Michigan's workforce needs.

e. Faculty who were instrumental in developing the program and faculty who will be responsible for implementing the program (see item 10).

Program Development

Teacher Education: Amelia Gotwals, Gail Richmond, David Stroupe

College of Natural Science: Danita Brandt (EES), Robert Drost (CISGS), Danielle Flores Lopez (Dean's Office), Matthew Oney (CISGS), Gabe Ording (CISGS), Kanchan Pavangadkar (Dean's Office), Lynmarie Posey (Dean's Office), Jon Stoltzfus (BS), Stuart Tessmer (PHY), Chrysoula Vasileiou (CEM)

Program Implementation

ISE Courses: Matthew Oney (CISGS), Robert Drost (CISGS)

Science Content Courses: Faculty from the following NatSci departments and programs: Biochemistry and Molecular Biology, Biological Sciences, Chemistry, Earth and Environmental Sciences, Integrative Biology, Mathematics, Microbiology and Molecular Genetics, Physics and Astronomy, Physiology, Plant Biology, Statistics and Probability

Professional Education Courses: Faculty from the Department of Teacher Education

Academic Advising: Danielle Flores-Lopez and Kanchan Pavangadkar (NatSci Dean's Office)

f. Plan for evaluating the program. Plan for assessing student outcomes. For academic major programs, indicate the learning objectives/goals for students and how outcomes will be assessed. Visit <http://www.reg.msu.edu/UCC/assessment.aspx> to complete the outcomes assessment form and include with the program submission.

Student Learning Outcomes

Students will:

1. build content knowledge in life science (biology), chemistry, earth and space science, and physics aligned with Michigan Department of Education *Standards for the Preparation of High School (grades 7-12) Science Teachers* and be able to demonstrate their understanding of core ideas in these disciplines through engagement with scientific practices.
2. develop the skills and knowledge necessary to plan, implement, and evaluate

- secondary science instruction appropriate to learner characteristics and social contexts.
3. be able to study, reflect, and learn from teaching experiences.
 4. demonstrate mastery of Teacher Preparation Program exit standards tied to the Michigan Department of Education's Core Teaching Practices.

Assessment of Student Learning Outcomes

Learning Outcome 1 (Science Content Knowledge)

Formative assessment of students' progress toward meeting this learning outcome will be provided by grades in required science courses in the College of Natural Science. Introductory science courses in biological sciences (BS), chemistry (CEM), and physics (PHY) place heavy emphasis on the use of knowledge through the scientific practices. Summative assessment of students' achievement of this learning outcome will be provided by cohort results on the Michigan Test for Teacher Certification (MTTC) in High School Science, which is required for certification to teach science in grades 7-12.

Learning Outcomes 2-4 (Teaching Practice)

Formative assessment of students' progress toward meeting these learning outcomes will be provided by grades in the required Professional Education courses in the College of Education. Evidence for achieving the learning outcomes centered on teaching practice will be provided by lesson plans developed during student teaching, student reflections on clinical and internship experiences, and observation and evaluation of teaching practice by field instructors and mentor teachers.

g. Program description including statement and specific requirements of the program as they will appear in the University catalog. Information contained in the catalog represents a University contract with students. Any deviation from college and University policies must be specifically requested. For a master's degree program, indicate whether Plan A (thesis) or B (non-thesis) or both will be available.

The integrated science-secondary education major, which leads to the Bachelor of Science degree, is designed for persons who want a broad background in biology, chemistry, earth and space science, and physics and to understand the interrelationships between these disciplines. This major is designed primarily for persons who plan to teach science (life science, chemistry, earth and space science, or physics) in secondary schools.

Requirements for the Bachelor of Science Degree in Integrated Science-Secondary Education

1. The University requirements for bachelor's degrees as described in the [Undergraduate Education](https://reg.msu.edu/AcademicPrograms/Text.aspx?Section=110) (<https://reg.msu.edu/AcademicPrograms/Text.aspx?Section=110>) section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Integrated Science-Secondary Education.

The University's Tier II writing requirement for the Integrated Science-Secondary Education major is met by completing ISE 401. That course is referenced in item 3.d. 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.

Students may substitute the TE 101 and TE 102 for the two required ISS courses. Students may substitute TE 341 for the first-level IAH requirement (courses numbered 201 through 210). Those courses are referenced in item 3.e. below.

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:

a.	One of the following groups of courses (9 or 10 credits):				
(1)	BS	161	Cell and Molecular Biology	3	
	BS	162	Organismal and Population Biology	3	
	BS	171	Cell and Molecular Biology Laboratory	2	
	BS	172	Organismal and Population Biology Laboratory	2	
(2)	BS	181H	Honors Cell and Molecular Biology	3	
	BS	182H	Honors Organismal and Population Biology	3	
	BS	191H	Honors Cell and Molecular Biology Laboratory	2	
	BS	192H	Honors Organismal and Population Biology Laboratory	2	
(3)	LB	144	Biology I: Organismal Biology	4	
	LB	145	Biology II: Cellular and Molecular Biology	5	
b.	One of the following groups of courses (9 or 10 credits):				
(1)	CEM	141	General Chemistry	4	
	CEM	142	General and Inorganic Chemistry	3	
	CEM	161	Chemistry Laboratory I	1	
	CEM	162	Chemistry Laboratory II	1	
(2)	CEM	151	General and Descriptive Chemistry	4	
	CEM	152	Principles of Chemistry	3	
	CEM	161	Chemistry Laboratory I	1	
	CEM	162	Chemistry Laboratory II	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
		LB	172L	Principles of Chemistry II-Reactivity Laboratory	1
c.	One of the following groups of courses (8 or 10 credits):				
	(1)	PHY	173	Studio Physics for Scientists and Engineers I	5
		PHY	174	Studio Physics for Scientists and Engineers II	5
	(2)	PHY	183	Physics for Scientists and Engineers I	4
		PHY	184	Physics for Scientists and Engineers II	4
		PHY	191	Physics Laboratory for Scientists, I	1
		PHY	192	Physics Laboratory for Scientists, II	1
	(3)	PHY	221	Studio Physics for Life Scientists I	4
		PHY	222	Studio Physics for Life Scientists II	4
	(4)	PHY	231	Introductory Physics I	3
		PHY	232	Introductory Physics II	3
		PHY	251	Introductory Physics Laboratory I	1
		PHY	252	Introductory Physics Laboratory II	1
	(5)	LB	273	Physics I	4
		LB	274	Physics II	4
d.	All of the following courses (14 credits):				
	IBIO	355		Ecology	3
	ISE	322		Foundational Earth Systems for Secondary Science Education	4
	ISE	401		Science Laboratories for Secondary Schools (W)	4
	ISE	420		Integrated Science Research	3
e.	The following Professional Education Courses in the College of Education (36 credits):				
	(1)	All of the following courses from the shared professional sequence (18 credits):			
		CEP	240	Diverse Learners in Multicultural Perspective	3
		TE	101	Social Foundations of Justice and Equity in Education	3
		TE	102	Pedagogy and Politics of Justice and Equity in Education	3
		TE	150	Reflections on Learning	3
		TE	302	Literacy and Adolescent Learners in School and Community Contexts	3
		TE	341	Teaching and Learning of (Bi)Multilingual Learners	3
	(2)	All of the following courses from the subject-specific professional sequence (18 credits):			
		TE	321	Clinical Experience in Science Education I	3
		TE	421	Clinical Experience in Science Education II	3
		TE	422	Seminar in Science Education I	3

	TE	423	Seminar in Science Education II		3
	TE	424	Student Teaching Internship in Science Education		6
f.	One of the following concentrations:				
	Biology				
(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
	(a)	MTH	124	Survey of Calculus I	3
		MTH	132	Calculus I	3
		MTH	152H	Honors Calculus I	3
		LB	118	Calculus I	4
	(b)	MTH	126	Survey of Calculus II	3
		MTH	133	Calculus II	4
		MTH	153H	Honors Calculus II	3
		LB	119	Calculus II	4
		STT	201	Statistical Methods	4
		STT	231	Statistics for Scientists	3
		STT	351	Probability and Statistics for Engineering	3
		STT	421	Statistics I	3
(2)	One of the following groups of courses (3 or 6 credits):				
	(a)	CEM	144	Organic Chemistry and Applications	3
	(b)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(c)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	All of the following courses (7 credits):				
	IBIO	341	Fundamental Genetics		4
	IBIO	355L	Ecology Laboratory		1
	IBIO	445	Evolution		3
(4)	One of the following courses (3 or 4 credits)				
	BMB	401	Comprehensive Biochemistry		4
	FW	417	Wetland Ecology and Management		3
	IBIO	408	Histology		4
	IBIO	425	Cells and Development (W)		4
	MMG	301	Introductory Microbiology		3
	NEU	300	Neurobiology		3
	PLB	415	Plant Physiology		3
	PLB	418	Plant Systematics		3
	PLB	441	Plant Ecology		3
	PSL	250	Introductory Physiology		4
	PSL	310	Physiology for Pre-Health Professionals		4

Chemistry					
(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
	(a)	MTH	132	Calculus I	3
		MTH	152H	Honors Calculus I	3
		LB	118	Calculus I	4
	(b)	MTH	133	Calculus II	4
		MTH	153H	Honors Calculus II	3
		LB	119	Calculus II	4
(2)	One of the following groups of courses (6 credits):				
	(a)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(b)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	All of the following courses (9 credits):				
	CEM	255	Organic Chemistry Laboratory		2
	CEM	262	Quantitative Analysis		3
	CEM	383	Introductory Physical Chemistry I		3
	CEM	444	Chemical Safety		1
(4)	One of the following courses (3 or 4 credits):				
	BMB	401	Comprehensive Biochemistry		4
	CEM	311	Inorganic Chemistry		3
	CEM	384	Introductory Physical Chemistry II		3
Physics					
(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
	(a)	MTH	132	Calculus I	3
		MTH	152H	Honors Calculus I	3
		LB	118	Calculus I	4
	(b)	MTH	133	Calculus II	4
		MTH	153H	Honors Calculus II	3
		LB	119	Calculus II	4
(2)	One of the following groups of courses (3 or 6 credits):				
	(a)	CEM	144	Organic Chemistry and Applications	3
	(b)	CEM	251	Organic Chemistry I	3
		CEM	252	Organic Chemistry II	3
	(c)	CEM	351	Organic Chemistry I	3
		CEM	352	Organic Chemistry II	3
(3)	All of the following courses (14 credits):				
	CMSE	201	Computational Modeling and Data Analysis I		4
	MTH	234	Multivariable Calculus		4

		MTH	235	Differential Equations	3	
		PHY	215	Thermodynamics and Modern Physics	3	
	(4)	One of the following courses (3 or 4 credits):				
		PHY	321	Classical Mechanics I	3	
		PHY	431	Optics I	3	
		PHY	440	Electronics	4	
		PHY	481	Electricity and Magnetism I	3	
		Earth Science				
	(1)	One course from group (a) and one course from group (b) (6 to 8 credits):				
		(a)	MTH	124	Survey of Calculus I	3
			MTH	132	Calculus I	3
			MTH	152H	Honors Calculus I	3
			LB	118	Calculus I	4
		(b)	MTH	126	Survey of Calculus II	3
			MTH	133	Calculus II	4
			MTH	153H	Honors Calculus II	3
			LB	119	Calculus II	4
			STT	201	Statistical Methods	4
			STT	231	Statistics for Scientists	3
			STT	351	Probability and Statistics for Engineering	3
			STT	421	Statistics I	3
	(2)	One of the following groups of courses (3 or 6 credits):				
		(a)	CEM	144	Organic Chemistry and Applications	3
		(b)	CEM	251	Organic Chemistry I	3
			CEM	252	Organic Chemistry II	3
		(c)	CEM	351	Organic Chemistry I	3
			CEM	352	Organic Chemistry II	3
	(3)	The following course (4 credits):				
		GLG	201	The Dynamic Earth	4	
	(4)	Two of the following courses (6 to 8 credits):				
		GLG	303	Oceanography	3	
		GLG	304	Physical and Biological History of the Earth	4	
		GLG	321	Mineralogy and Geochemistry	4	
		GLG	361	Igneous and Metamorphic Geochemistry and Petrology	4	
		GLG	401	Global Tectonics and Earth Structure (W)	4	
		GLG	411	Hydrogeology	3	
		GLG	412	Glacial Geology and the Record of Climate Change	4	
		GLG	421	Environmental Geochemistry	4	
		GLG	435	Geomicrobiology	4	
		GLG	440	Planetary Geology	3	

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h. If the program will be offered in a location other than the main campus in East Lansing, specify the location (s).

Required courses will be delivered on the main campus in East Lansing with placements for clinical experiences and student teaching internships in Michigan schools.

i. List the name and describe any certificate program that is associated with a new or extant degree program.

- Explain the relationship between the certificate program and a new or extant degree program.

N/A

- If a certificate program is being proposed that is related to a degree program, please explain how the department/school/college will learn that the supervising faculty have endorsed the potential certificate holders as possessing specified skills or competency levels that render them eligible to receive the certificate and the degree.

N/A

j. Other information that will assist the Provost and the University-level committees in evaluating the request.

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: College of Natural Science
1/21/2023 12:03:54 PM by Lynmarie Posey for Phillip M. Duxbury, Dean

Comments: Approved by NatSci Curriculum Committee on 1/17/23.

SIGNOFFS STATUS

Signed Off: College of Agriculture and Natural Resources
1/21/2023 1:29:42 PM by Dorcia Chaison

Signed Off: College of Education
2/2/2023 11:47:47 AM by Carrie Oney for Kristine Bowman, Associate Dean

Signed Off: Lyman Briggs College
1/25/2023 2:11:53 PM by Niki Rudolph

Signed Off: Department of Biochemistry and Molecular Biology
1/23/2023 1:54:01 PM by Mary Villarreal

Signed Off: Biological Science Program
1/21/2023 2:54:18 PM by Jon Stoltzfus for Gerard Mark Voit, Associate Dean

Signed Off: Department of Chemistry
1/23/2023 9:16:48 AM by Sheba Onchiri for Timothy H. Warren, Chairperson

Signed Off: Department of Counseling, Educational Psychology, and Special Education
1/31/2023 3:21:49 PM by Cary Roseth for Cary J Roseth, Chairperson

Signed Off: Department of Earth and Environmental Sciences
1/23/2023 11:20:47 AM by Susannah Dorfman for Jeffrey Freymueller, Chairperson

Signed Off: Department of Fisheries and Wildlife
1/21/2023 1:29:58 PM by Dorcia Chaison for Gary Roloff, Chairperson

Signed Off: Department of Integrative Biology
2/3/2023 11:10:33 AM by Teresa McElhinny for Tom Getty, Chairperson

Comments: The IBIO Curriculum Committee suggests adding IBIO 328 Comparative Anatomy of the Vertebrates to the Biology Concentration selective group 4.

Signed Off: Center for Integrative Studies in General Science
1/23/2023 9:14:58 AM by Julie Pozega for Gabriel Ording, Director

Signed Off: Department of Mathematics
2/3/2023 9:30:32 AM by Brian Chadwick for Keith Promislow, Chairperson

Signed Off: Department of Microbiology and Molecular Genetics
1/21/2023 3:32:46 PM by Mulrooney Scott B. for Victor J. DiRita, Chairperson

Signed Off: Department of Physics and Astronomy
1/21/2023 4:19:25 PM by Stuart Tessmer for Stephen E. Zepf, Chairperson

Signed Off: Department of Physiology
1/22/2023 10:12:52 AM by Karl Olson for Charles Leroy Cox, Chairperson

Signed Off: Department of Plant Biology
1/22/2023 8:52:10 PM by Tammy Long for Jiming Jiang, Chairperson

Signed Off: Department of Statistics and Probability

1/23/2023 10:38:15 AM by Leonard Johnson for Lyudmila Sakhanenko, Chairperson

Signed Off: Department of Teacher Education

2/3/2023 3:54:16 PM by Dorinda Carter for Dorinda J. Carter Andrews, Chairperson

COLLEGE LEVEL APPROVAL STATUS

Approved: College of Natural Science

2/3/2023 6:17:16 PM by Lynmarie Posey for LynnMarie Posey, Associate Dean

Comments: Approved by NatSci Curriculum Committee on 1/17/23.

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TEACHER CERTIFICATION OPTIONS

The following disciplinary majors leading to bachelor's degrees in the College of Natural Science are available for teacher certification: biological science–interdepartmental, chemistry, ~~mathematics~~, physical science–interdepartmental, and physics.

← mathematics-secondary education

The following disciplinary minors in the College of Natural Science are also available for teacher certification: biology, chemistry, earth science, mathematics, and physics.

Students interested in elementary teacher certification in science should reference the section on *MSU SUBJECT MATTER TEACHING MAJORS AND MINORS FOR TEACHER PREPARATION AND CERTIFICATION* in the *Department of Teacher Education* section of this catalog.

Students who elect the biological science–interdepartmental or the physical science–interdepartmental disciplinary major, or the biology disciplinary minor, must contact the Center for Integrative Studies in General Science in the College of Natural Science.

Students who elect a chemistry disciplinary major or the chemistry disciplinary minor must contact the Department of Chemistry.

Students who elect the earth science disciplinary minor must contact the Department of Earth and Environmental Sciences.

Students who elect a mathematics disciplinary major or the mathematics disciplinary minor must contact the Department of Mathematics.

Students who elect a physics disciplinary major or the physics disciplinary minor must contact the Department of Physics and Astronomy.

For additional information, refer to the statements on the disciplinary majors referenced above and to the statement on *TEACHER CERTIFICATION* in the *Department of Teacher Education* section of this catalog.

INTEGRATED SCIENCE-SECONDARY EDUCATION

The Bachelor of Science Degree in Integrated Science-Secondary Education is designed for persons who want a broad background in biology, chemistry, earth and space science, and physics and to understand the interrelationships between these disciplines. This major is designed primarily for persons who plan to teach science (life science, chemistry, earth and space science, or physics) in secondary schools.

Requirements for the Bachelor of Science Degree in Integrated Science-Secondary Education

CREDITS

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 Integrated Science-Secondary Education.

The University's Tier II writing requirement for the Integrated Science-Secondary Education major is met by completing Integrated Science Education 401. That course is 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.

Students may substitute Teacher Education 101 and 102 for two ISS requirements. Students may substitute Teacher Education 341 for the first-level IAH requirement (courses numbered 201 through 210). Those courses are referenced in item 3. below.
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:
 - a. One of the following groups of courses (9 or 10 credits):

(1)	BS	161	Cell and Molecular Biology	3
	BS	162	Organismal and Population Biology	3
	BS	171	Cell and Molecular Biology Laboratory	2
	BS	172	Organismal and Population Biology Laboratory	2
(2)	BS	181H	Honors Cell and Molecular Biology	3
	BS	182H	Honors Organismal and Population Biology	3
	BS	191H	Honors Cell and Molecular Biology Laboratory	2
	BS	192H	Honors Organismal and Population Biology Laboratory	2
(3)	LB	144	Biology I: Organismal Biology	4
	LB	145	Biology II: Cellular and Molecular Biology	5
 - b. One of the following groups of courses (9 or 10 credits):

(1)	CEM	141	General Chemistry	4
	CEM	142	General and Inorganic Chemistry	3
	CEM	161	Chemistry Laboratory I	1
	CEM	162	Chemistry Laboratory II	1
(2)	CEM	151	General and Descriptive Chemistry	4
	CEM	152	Principles of Chemistry	3
	CEM	161	Chemistry Laboratory I	1
	CEM	162	Chemistry Laboratory II	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

	LB	172L	Principles of Chemistry II-Reactivity Laboratory	1
c.	One of the following groups of courses (8 or 10 credits):			
(1)	PHY	173	Studio Physics for Scientists and Engineers I	5
	PHY	174	Studio Physics for Scientists and Engineers II	5
(2)	PHY	183	Physics for Scientists and Engineers I	4
	PHY	184	Physics for Scientists and Engineers II	4
	PHY	191	Physics Laboratory for Scientists, I	1
	PHY	192	Physics Laboratory for Scientists, II	1
(3)	PHY	221	Studio Physics for Life Scientists I	4
	PHY	222	Studio Physics for Life Scientists II	4
(4)	PHY	231	Introductory Physics I	3
	PHY	232	Introductory Physics II	3
	PHY	251	Introductory Physics Laboratory I	1
	PHY	252	Introductory Physics Laboratory II	1
(5)	LB	273	Physics I	4
	LB	274	Physics II	4
d.	All of the following courses (14 credits):			
	IBIO	355	Ecology	3
	ISE	322	Foundational Earth Systems for Secondary Science Education	4
	ISE	401	Science Laboratories for Secondary Schools (W)	4
	ISE	420	Integrated Science Research	3
e.	The following Professional Education Courses in the College of Education (36 credits):			
(1)	All of the following courses from the shared professional sequence (18 credits):			
	CEP	240	Diverse Learners in Multicultural Perspective	3
	TE	101	Social Foundations of Justice and Equity in Education	3
	TE	102	Pedagogy and Politics of Justice and Equity in Education	3
	TE	150	Reflections on Learning	3
	TE	302	Literacy and Adolescent Learners in School and Community Contexts	3
	TE	341	Teaching and Learning of (Bi)Multilingual Learners	3
(2)	All of the following courses from the subject-specific professional sequence (18 credits):			
	TE	321	Clinical Experience in Science Education I	3
	TE	421	Clinical Experience in Science Education II	3
	TE	422	Seminar in Science Education I	3
	TE	423	Seminar in Science Education II	3
	TE	424	Student Teaching Internship in Science Education	6
f.	One of the following concentrations:			
	Biology			
(1)	One course from group (a) and one course from group (b) (6 to 8 credits):			
(a)	MTH	124	Survey of Calculus I	3
	MTH	132	Calculus I	3
	MTH	152H	Honors Calculus I	3
	LB	118	Calculus I	4
(b)	MTH	126	Survey of Calculus II	3
	MTH	133	Calculus II	4
	MTH	153H	Honors Calculus II	3
	LB	119	Calculus II	4
	STT	201	Statistical Methods	4
	STT	231	Statistics for Scientists	3
	STT	351	Probability and Statistics for	

			Engineering	3
	STT	421	Statistics I	3
(2)	One of the following groups of courses (3 or 6 credits):			
	(a)	CEM	144 Organic Chemistry and Applications	3
	(b)	CEM	251 Organic Chemistry I	3
		CEM	252 Organic Chemistry II	3
	(c)	CEM	351 Organic Chemistry I	3
		CEM	352 Organic Chemistry II	3
(3)	All of the following courses (7 credits):			
	IBIO	341	Fundamental Genetics	4
	IBIO	355L	Ecology Laboratory (W)	1
	IBIO	445	Evolution (W)	3
(4)	One of the following courses (3 or 4 credits)			
	BMB	401	Comprehensive Biochemistry	4
	FW	417	Wetland Ecology and Management	3
	IBIO	408	Histology	4
	IBIO	425	Cells and Development (W)	4
	MMG	301	Introductory Microbiology	3
	NEU	300	Neurobiology	3
	PLB	415	Plant Physiology	3
	PLB	418	Plant Systematics	3
	PLB	441	Plant Ecology	3
	PSL	250	Introductory Physiology	4
	PSL	310	Physiology for Pre-Health Professionals	4

Chemistry

(1)	One course from group (a) and one course from group (b) (6 to 8 credits):			
	(a)	MTH	132 Calculus I	3
		MTH	152H Honors Calculus I	3
		LB	118 Calculus I	4
	(b)	MTH	133 Calculus II	4
		MTH	153H Honors Calculus II	3
		LB	119 Calculus II	4
(2)	One of the following groups of courses (6 credits):			
	(a)	CEM	251 Organic Chemistry I	3
		CEM	252 Organic Chemistry II	3
	(b)	CEM	351 Organic Chemistry I	3
		CEM	352 Organic Chemistry II	3
(3)	All of the following courses (9 credits):			
	CEM	255	Organic Chemistry Laboratory	2
	CEM	262	Quantitative Analysis	3
	CEM	383	Introductory Physical Chemistry I	3
	CEM	444	Chemical Safety	1
(4)	One of the following courses (3 or 4 credits):			
	BMB	401	Comprehensive Biochemistry	4
	CEM	311	Inorganic Chemistry	3
	CEM	384	Introductory Physical Chemistry II	3

Physics

(1)	One course from group (a) and one course from group (b) (6 to 8 credits):			
	(a)	MTH	132 Calculus I	3
		MTH	152H Honors Calculus I	3
		LB	118 Calculus I	4
	(b)	MTH	133 Calculus II	4
		MTH	153H Honors Calculus II	3
		LB	119 Calculus II	4
(2)	One of the following groups of courses (3 or 6 credits):			
	(a)	CEM	144 Organic Chemistry and Applications	3
	(b)	CEM	251 Organic Chemistry I	3
		CEM	252 Organic Chemistry II	3
	(c)	CEM	351 Organic Chemistry I	3
		CEM	352 Organic Chemistry II	3

- (3) All of the following courses (14 credits):
- | | | | |
|------|-----|--|---|
| CMSE | 201 | Computational Modeling and Data Analysis I | 4 |
| MTH | 234 | Multivariable Calculus | 4 |
| MTH | 235 | Differential Equations | 3 |
| PHY | 215 | Thermodynamics and Modern Physics | 3 |
- (4) One of the following courses (3 or 4 credits):
- | | | | |
|-----|-----|-----------------------------|---|
| PHY | 321 | Classical Mechanics I | 3 |
| PHY | 431 | Optics I | 3 |
| PHY | 440 | Electronics | 4 |
| PHY | 481 | Electricity and Magnetism I | 3 |

Earth Science

- (1) One course from group (a) and one course from group (b) (6 to 8 credits):
- (a)
- | | | | |
|-----|------|----------------------|---|
| MTH | 124 | Survey of Calculus I | 3 |
| MTH | 132 | Calculus I | 3 |
| MTH | 152H | Honors Calculus I | 3 |
| LB | 118 | Calculus I | 4 |
- (b)
- | | | | |
|-----|------|---|---|
| MTH | 126 | Survey of Calculus II | 3 |
| MTH | 133 | Calculus II | 4 |
| MTH | 153H | Honors Calculus II | 3 |
| LB | 119 | Calculus II | 4 |
| STT | 201 | Statistical Methods | 4 |
| STT | 231 | Statistics for Scientists | 3 |
| STT | 351 | Probability and Statistics for
Engineering | 3 |
| STT | 421 | Statistics I | 3 |
- (2) One of the following groups of courses (3 or 6 credits):
- (a) CEM 144 Organic Chemistry and Applications 3
- (b) CEM 251 Organic Chemistry I 3
- CEM 252 Organic Chemistry II 3
- (c) CEM 351 Organic Chemistry I 3
- CEM 352 Organic Chemistry II 3
- (3) The following course (4 credits):
- | | | | |
|-----|-----|-------------------|---|
| GLG | 201 | The Dynamic Earth | 4 |
|-----|-----|-------------------|---|
- (4) Two of the following courses (6 to 8 credits):
- | | | | |
|-----|-----|---|---|
| GLG | 303 | Oceanography | 3 |
| GLG | 304 | Physical and Biological History of the Earth | 4 |
| GLG | 321 | Mineralogy and Geochemistry | 4 |
| GLG | 361 | Igneous and Metamorphic Geochemistry
and Petrology | 4 |
| GLG | 401 | Global Tectonics and Earth Structure (W) | 4 |
| GLG | 411 | Hydrogeology | 3 |
| GLG | 412 | Glacial Geology and the Record of Climate
Change | 4 |
| GLG | 421 | Environmental Geochemistry | 4 |
| GLG | 435 | Geomicrobiology | 4 |
| GLG | 440 | Planetary Geology | 3 |