COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

Matt Daum, Interim DEAN

The first college at the first land-grant institution, the College of Agriculture and Natural Resources is committed to advancing knowledge and transforming lives in communities, agriculture, natural resources, built spaces, and packaging systems. The college provides innovative leadership in science, technology, design, management, biofuels, the bioeconomy, and international involvement. Academic programs in the college build on strong foundations in science, technology, engineering and mathematics (STEM). The wide selection of academic programs and career pathways include food, nutrition, and their applications to health; community, family and youth development; agricultural production; technology, management, and design; food processing; biofuels, the bioeconomy, globalization, international development, packaging, building construction, and sustainability.

Students learn to manage resources, people, and technology to improve the use, conservation and renewal of natural and created environments; develop sustainable systems; manage green spaces; enhance community and economic development; and advance packaging systems, food safety and nutrition. Graduates are employed as scientists, leaders, educators, managers, and stewards of human and natural resources.

The diverse disciplines and expertise in the college encompass research in animal and plant biotechnology, control of invasive species, control of pathogens, protection of biodiversity, management of urban sprawl, environmental remediation, wildlife management, use of biosensors to detect foodborne pathogens, tourism, ergonomics and lean construction, packaging materials and systems, and the sustainability of agricultural and natural resource systems. Knowledge derived from research is integrated into course work and extended to benefit the community, state, nation and world – epitomizing the excellence of the land-grant tradition.

Educational programs nurture a learning environment that educates and prepares students for graduate study and/or for leadership in local, state, national, and international arenas. Graduates of the college have the tools they need to undertake endeavors that ensure the sustainability of food, prosperity and leisure activities in a world environment that has finite resources. For those interested in short-term certificate programs, the Institute of Agricultural Technology offers a variety of technical programs that are less than two years in length.

UNDERGRADUATE PROGRAMS

Personal attention is a key aspect of all college programs, and undergraduate research is promoted and encouraged. The college offers a highly student-oriented advising system. Students are assigned an academic advisor to suggest courses and career emphases. In the student-advisor relationship, the capabilities, aspirations and goals of the students remain paramount throughout their academic careers. Academic advisors work closely with students from the time they express an interest in the major, and undergraduate research is encouraged in all majors.

For students who desire one of the degree options available through the college, but wish to delay their choice of a specific major until a later date, a no–preference program is offered. Under this arrangement, first-year students enrolled in the Neighborhood Student Success Collaborative may designate their major preference as Agriculture and Natural Resources No–Preference. Students selecting this major preference are advised by faculty members in the College of Agriculture and Natural Resources. Through careful selection of courses, they are encouraged to explore a variety of areas to help in selecting a major. The key element of this program is its flexibility. Students may remain in it until they attain sophomore or junior standing, or they may select other major preferences at any time before becoming juniors.

Bachelor of Science degree programs are offered in the following areas: Agribusiness Management; Agriculture, Food and Natural Resources Education; Animal Science; Construction Management; Crop and Soil Sciences; Dietetics; Entomology; Environmental Economics and Management; Environmental Studies and Sustainability; Fisheries and Wildlife; Food Industry Management; Food Science; Forestry; Horticulture; Nutritional Sciences; Packaging; and Sustainable Parks, Recreation and Tourism. A Bachelor of Arts degree program in Interior Design and a Bachelor of Landscape Architecture degree program in Landscape Architecture are also offered.

The College of Agriculture and Natural Resources cooperates with the College of Engineering in offering an undergraduate program in Biosystems Engineering. The college also participates with the College of Social Science in offering an undergraduate program in Urban and Regional Planning.

Students who are enrolled in bachelor's degree programs in the college may elect the Minor in Environmental and Sustainability Studies. For additional information, refer to the statement on *Minor in Environmental and Sustainability Studies* in the *College of Natural Science* section of this catalog.

Honors Study

The College of Agriculture and Natural Resources encourages honors students to develop enriched and distinctive undergraduate programs. In each of the career pathways offered in the college, members of the faculty are carefully selected to serve as departmental Honors College advisors. These advisors assist each Honors College student in planning a rigorous and balanced program that reflects individual interests and competencies. In addition to the university–wide array of introductory Honors courses available to exceptional students, the college encourages participation in research and enrollment in graduate courses and independent study.

Opportunities for Individual Emphasis

In furthering the students' education, the flexible nature of the program in each major makes it possible for students to pursue areas of special interest through regular course work, special seminars, research and travel. By anticipating new and growing areas of need for trained personnel, the college makes it possible for students to prepare themselves

adequately in these areas. Following are a few of the opportunities for special emphasis available to students in any major within the college.

International Study. The college offers opportunities for short-term and semester-length study abroad programs around the world. Undergraduates are encouraged to make a study abroad experience part of their curriculum. In addition, students in the College of Agriculture and Natural Resources, and others interested in agricultural development abroad, may select courses from numerous subject areas. Offerings in agricultural economics, agricultural engineering, animal science, crop and soil sciences, extension personnel development, forestry, horticulture and resource development have special relevance to international agriculture and rural development. Emphasis is placed on environmentally sound crop and animal production, application of new technical knowledge, planning and administration, and efficient use of human and natural resources for developing countries.

Science Emphasis. Many students realize early in their college years that they wish to prepare for careers in research or university teaching. Academic advisors assist them in selecting science courses (biological, physical and social) and mathematics courses that will offer the best possible preparation for graduate study.

Undergraduate Research. The college Undergraduate Research Program allows students to become more actively engaged in their education through intellectual inquiry and practical learning. Students work closely with a faculty mentor to conduct original research in the chosen area of interest.

Freshmen

Students meeting the general requirements for admission shown in the Undergraduate Education section of this catalog are enrolled in the Neighborhood Student Success Collaborative (NSSC). However, they may declare a major preference in the College of Agriculture and Natural Resources and be assigned an academic advisor in the College. Freshmen who declare a major will usually have both an NSSC advisor and an advisor in their major.

Admission to the College of Agriculture and Natural Resources

1. Completion of at least 28 credits acceptable to the college with an academic record, which at least meets the requirements of Academic Standing of Undergraduate Students.
2. Acceptance as a major in one of the academic programs of the college.

Several majors within the College have limited enrollment and may admit students only upon reaching junior standing or have other requirements that must be met prior to admission to the major. These majors include construction management, dietetics, interior design, landscape architecture, and packaging. For additional information, refer to the statements on the Department of Food Science and Human Nutrition, School of Packaging, and the School of Planning, Design and Construction.

Students with fewer than 28 credits may designate a major preference within the College of Agriculture and Natural Resources. Students selecting a major preference within the College are advised by faculty members or advisors in the

College of Agriculture and Natural Resources. Graduation Requirements

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog.

   Alternative tracks to Integrative Studies in General Science have been approved for selected majors leading to the Bachelor of Science degree in the college. For additional information, refer to the lists of requirements for the major and degree programs that appear in the statements on the departments.

   The completion of the College of Agriculture and Natural Resources mathematics requirement referenced in item 2. a. below may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree that are listed below:
   a. The mathematics requirement may be met by completing one of the following or may be satisfied by placing into a calculus course based on the Mathematic Services Placement Exam.
      (1) Mathematics 103 and Statistics and Probability 200 or 201.
      (2) Mathematics 103 and 114.
      (3) Mathematics 116.
   b. Economics 201 or 202.
   c. At least 26 credits in courses in the college.
   d. The specific requirements for a major in the college.

Students who are enrolled in bachelor's degree programs in the College of Agriculture and Natural Resources may elect a Minor in Environmental and Sustainability Studies. For additional information, refer to the *Minor in Environmental and Sustainability Studies* statement in the *College of Natural Science* section of this catalog.

MINOR IN LEADERSHIP IN INTEGRATED LEARNING

The Minor in Leadership in Integrated Learning is available as an elective to undergraduate students whom the college has identified as Liberty Hyde Bailey Scholars. The minor is administered by the College of Agriculture and Natural Resources. The Director of the Liberty Hyde Bailey Scholars Program coordinates the minor on behalf of the Dean. The minor provides an opportunity for students to develop a leadership identity that reflects integration of ideas across social, economic, environmental, and cultural domains in addition to disciplinary learning. Students participate actively in the learning experience by developing individualized plans of study and assessment through course work in the minor. Students develop a variety of inquiry strategies though exploration of service learning, social justice and diversity, community building, problem solving, meaning making, and transformative systems thinking. Leadership, learning experiences, and reflections are documented in the student's

learning e-portfolio and are presented during the culminating experience.

With the approval of the department that administers the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Leadership in Integrated Learning

		CREDITS
The student must complete:		
1. An individualized plan of study approved by the Director of the Bailey Scholars Program including:		
a. All of the following courses (9 credits):		
ANR 210	Pathways in Integrated Learning	3
ANR 310	Integrated Learning Seminar I	3
ANR 410	Integrated Learning Transitions	3
b. At least 9 additional credits in approved courses. A list of approved courses is available from the Director.		

TEACHER CERTIFICATION OPTIONS

The agriculture, food and natural resources education disciplinary major leading to the Bachelor of Science degree in the College of Agriculture and Natural Resources is available for teacher certification.

The agriculture, food and natural resources education disciplinary minor in the College of Agriculture and Natural Resources is also available for teacher certification.
In addition, vocational endorsement in agricultural education is available to persons who meet specified requirements. Students who elect the agriculture, food and natural resources education disciplinary major, or the agriculture, food and natural resources education disciplinary minor, must contact the Department of Community Sustainability. For additional information, refer to the statement on the agriscience disciplinary major and to the statement on *TEACHER CERTIFICATION* in the *Department of Teacher Education* section of this catalog.

GRADUATE STUDY

Through its graduate programs, the College of Agriculture and Natural Resources seeks to provide opportunities for advanced study, original research and supervised experience in teaching, coupled with a broadening of a student's educational background.

The College of Agriculture and Natural Resources offers graduate study leading to the Master of Science degree in the following majors: agricultural, food and resource economics; animal science; biosystems engineering; construction management; community sustainability; crop and soil sciences; dietetics; fisheries and wildlife; food science; forestry; horticulture; human nutrition; nutrition and dietetics, packaging; plant breeding, genetics and biotechnology–crop and soil sciences; plant breeding, genetics and biotechnology–forestry; plant breeding, genetics and biotechnology–horticulture; plant breeding, genetics and biotechnology-plant biology; plant pathology; and sustainable tourism and protected area management. A master's degree program is offered jointly with the College of Business. Qualified students may earn joint master's degrees in forestry and business administration.

The College of Agriculture and Natural Resources offers graduate study leading to the Master of Arts degree in Environmental Design.

The Master of Urban and Regional Planning degree program with a major in urban and regional planning is offered through the College of Social Science. For information about that program, refer to the statement on the *School of Planning, Design and Construction* in the *College of Social Science* section of this catalog.

Students may complete a professional dietetics internship certificate program through the Department of Food Science and Human Nutrition.

The Doctor of Philosophy degree may be earned with majors in agricultural, food and resource economics; agricultural engineering; animal science; biosystems engineering; community sustainability; crop and soil sciences; entomology; fisheries and wildlife; food science; forestry, horticulture; human nutrition; packaging; planning, design and construction; plant breeding, genetics and biotechnology – crop and soil sciences; plant breeding, genetics and biotechnology—forestry; plant breeding, genetics and biotechnology—horticulture; plant breeding, genetics and biotechnology-plant biology; plant pathology; and sustainable tourism and protected area management.

The following dual Juris Doctor (J.D.) programs with Michigan State University College of Law are available through the College of Agriculture and Natural Resources: Michigan State University M.S. degree program with a major in Fisheries and Wildlife and Michigan State University College of Law J.D.; Michigan State University M.S. degree program with a major in Forestry and Michigan State University College of Law J.D.

The regulations and requirements presented here are the minimum for the college as a whole and must be fulfilled by all students in all departments. Any requirements not set forth herein or in university regulations are matters of departmental policy. Individual departments may have additional requirements beyond the minimum established for the college. Admissions to graduate programs may be limited by unit resources.

Graduate Specializations and Certificates

Students who are enrolled in master's and doctoral degree programs may elect the Graduate Certificate in Conservation Law. For additional information, refer to the statement on *Graduate Certificate in Conservation Law* in the *Department of Fisheries and Wildlife* section of this catalog.

Students who are enrolled in master's and doctoral degree programs may elect the Graduate Certificate in Forest Carbon Science, Policy and Management. For additional information, refer to the statement on *Graduate Certificate in Forest Carbon Science, Policy and Management* in the *Department of Forestry* section of this catalog.

Students who are enrolled in doctoral degree programs in departments and programs emphasizing environmental science and policy may elect the Graduate Specialization in Environmental Science and Policy. For additional

information, refer to the *Graduate Specialization in Environmental Science and Policy* statement in the *College of Social Science* section of this catalog.

Students who are enrolled in master's and doctoral degree programs in the College of Agriculture and Natural Resources, the College of Natural Science, and the College of Veterinary Medicine may elect the Graduate Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine. For additional information, refer to the statement on *Graduate Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine*.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of Food Science and Human Nutrition may elect a Interdepartmental Graduate Specialization in Infancy and Early Childhood. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Infancy and Early Childhood* in the *College of Social Science* section of this catalog.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the departments of Agricultural, Food, and Resource Economics; Fisheries and Wildlife; or Forestry may elect a Graduate Specialization in Environmental and Resource Economics. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Environmental and Resource Economics*.

Master of Science

In addition to meeting the requirements of the university, students must meet the requirements specified below.

Admission

Acceptance of an applicant is determined by the department in which the applicant wishes to do his or her major work, with the approval of the dean of the college, after consideration of the applicant's academic record, experience, personal qualifications, and objectives. Applicants who are admitted are classified in one of two groups: **regular**, for students who are fully qualified to undertake master's degree programs, or **provisional**, for students who have some remediable inadequacy of qualifications, or deficiency in subject matter preparation.

Normally an undergraduate grade–point average of 3.00 (B) or higher is required for admission to any status. Credits earned in regular or provisional status are acceptable as part of a student's degree requirements upon approval of the major professor and the dean.

Requirements for the Master of Science Degree

PROGRAM. The student, in consultation with the major professor, develops the prescribed program of study. The program should be established at the earliest possible date, consistent with departmental requirements, and filed with the department and the dean. Two plans of study are available:

Plan A—Completion of a research program and preparation of a satisfactory thesis are required. Research credits must equal at least 6, but not more than 10.

Plan B—Preparation of a thesis is not required. The program may include research or special problems not exceeding 6 credits.

EXAMINATION. The candidate must pass a final examination on the program of study before a committee selected by the major professor and approved by the department chairperson, in accordance with University and departmental policy for Plan A and Plan B programs.

In case of a failure, the student may appear for reexamination at a time specified by the examining committee.

Academic Standards

FOR RETENTION. The major professor and department in which the student is majoring review and make a decision concerning the retention of any student failing to fulfill departmental requirements, and may dismiss a student at the end of any semester. Notice of dismissal from a departmental program is given to the student by the department chairperson, and the dean is notified of such action.

Residence

The student should spend at least one full semester in residence on campus. At least 8 credits excluding research must be taken in course work on the campus in East Lansing.

Doctor of Philosophy

The Doctor of Philosophy degree is granted for distinctive attainment by the student in a special field, as evidenced by a dissertation which shows independent and creative thought and by passing detailed examinations over the student's chosen fields.

In addition to meeting the requirements of the university, students must meet the requirements specified below.

Admission

Acceptance of an applicant is determined by the department in which the applicant wishes to do his or her major work, with the approval of the dean of the college, after consideration of the applicant's academic record, experience, personal qualifications, and objectives. Applicants who are admitted are classified in one of two groups: **regular**, for students whose records and qualifications show that they are ready to pursue a course of study toward the doctorate, or **provisional**, for students who, although their previous work appears to have been at an acceptably high academic level, nevertheless lack some important requirements for the course of study they intend to follow toward the doctorate. Such deficiencies will often necessitate the completion of

collateral courses for which credit will not be counted toward the degree.

Normally a grade–point average of 3.00 (B) or higher in all previous academic work is required for admission to regular or provisional status.

Admission is open to students with a master's or bachelor's degree or their equivalents; however, applicants meeting these requirements are not guaranteed admission into a doctoral program. Some departments may require completion of a master's degree prior to admission into the doctoral program.

Credits earned in regular or provisional status are acceptable as part of a student's degree requirements upon approval by the guidance committee and the dean.

Examinations

COMPREHENSIVE. A comprehensive knowledge of the student's major and related fields must be demonstrated by examination, written or written and oral, to the guidance committee. If the student fails to pass, there may not be a reexamination until after one semester of additional work toward the degree is completed.

FINAL. The final oral examination, primarily in defense of the dissertation, is conducted by the guidance committee, supplemented, at the discretion of the dean, by two appointed faculty members. Other faculty members may attend at the chairperson's discretion. The final oral examination cannot be conducted before the dissertation is in the final form unbound.

Academic Standards

FOR RETENTION. The guidance committee and the department in which the student is majoring review and make a decision concerning the retention of any student failing to fulfill departmental requirements, and may dismiss a student at the end of any semester. Notice of dismissal from a departmental program is given to the student by the department chairperson, and the dean is notified of such action.

Residence

One year of residence after completion of the master's degree or its equivalent is required. This permits the student to work with and under the direction of the faculty, and to engage in independent and cooperative research utilizing university facilities. Normally, the year of residence will be made up of two semesters involving completion of at least 9 credits of graduate work each semester.

INTERDEPARTMENTAL GRADUATE PROGRAM in PLANT BREEDING, GENETICS and BIOTECHNOLOGY

The interdepartmental graduate program in Plant Breeding, Genetics and Biotechnology is jointly administered by the departments of Crop and Soil Sciences, Forestry, Horticulture, and Plant Biology. Faculty who have been identified by the chairpersons of these departments are members of the Plant Breeding, Genetics and Biotechnology Program. One member of the faculty is designated as the Coordinator and oversees the program.

The interdepartmental graduate program in Plant Breeding, Genetics and Biotechnology is designed to:

1. Provide contemporary graduate education and training in the field of plant breeding and genetics, so that students may be prepared to teach, conduct independent research, and use modern technologies.
2. Enable students to gain knowledge in the various disciplines that support plant breeding activities through course work in such fields as biochemistry, plant physiology, entomology, plant pathology, and food science.
3. Provide an intellectual and resource environment conducive to graduate research.
4. Foster an awareness of plant breeding and genetics programs in both the public and private sectors.

Master of Science

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

A student seeking admission to the Plant Breeding, Genetics and Biotechnology program at the master's level must have completed a Bachelor of Science degree in a plant science or related field with an emphasis on plant breeding and genetics. A minimum grade–point average of 3.00 in courses in agricultural, biological, and physical sciences and an academic background sufficient to indicate probable success in the program are required.

To be considered for admission to the program, the student must be accepted as an advisee by a faculty member in the student's major department who is also a member of the Plant Breeding, Genetics and Biotechnology faculty. Admission to the program is by approval of one of the four participating departments, the Plant Breeding, Genetics and Biotechnology faculty, and the Coordinator of the Plant Breeding, Genetics and Biotechnology Program. In special cases, applicants with deficiencies in background courses may be admitted on a provisional basis. Such students will not be considered for advanced degrees until they have fulfilled the requirements for admission to regular status.

Requirements for the Master of Science Degree

The student's guidance committee, selected in consultation with the student and the major professor at the time that the student is admitted to the program, plans the student's course of study with the student's particular interests, capabilities, and professional goals in mind. The student's guidance committee is composed of three faculty members; the student's major professor and at least one other person must be members of the Plant Breeding, Genetics and Biotechnology faculty. At least one member must be from a department other than the one that administers the student's major.

Only Plan A (with thesis) is available. The student is required to complete courses, learn research methodologies, and conduct thesis research pertinent to the plant species under study. The student must complete two credits of Horticulture 892, and two core courses as specified by the Plant Breeding, Genetics and Biotechnology faculty. Credits in Master's Thesis Research (course number 899) must total at least 6 but not more than 10. One semester of teaching experience is also required. The student's program will be reviewed by the Plant Breeding, Genetics and Biotechnology faculty. The degree is conferred upon recommendation of the department, the Coordinator of the Plant Breeding, Genetics and Biotechnology Program, and the Dean of the college.

Doctor of Philosophy

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

A student seeking admission to the Plant Breeding, Genetics and Biotechnology program at the doctoral level must have completed a Bachelor or Master of Science degree in the plant sciences with an emphasis on plant breeding and genetics. A minimum grade–point average of 3.00 is required.

To be considered for admission to the program, the student must be accepted as an advisee by a faculty member in the student's major department who is also a member of the Plant Breeding, Genetics and Biotechnology faculty. Admission to the program is by approval of one of the four participating departments, the Plant Breeding, Genetics and Biotechnology faculty, and the Coordinator of the Plant Breeding, Genetics and Biotechnology Program.

Requirements for the Doctor of Philosophy Degree

The guidance committee, selected in consultation with the student and the major professor at the time that the student is admitted to the program, plans the student's course of study with the student's particular interests, capabilities, and professional goals in mind. The student's guidance committee is composed of four faculty members; the student's major professor and at least one other person must be members of the Plant Breeding, Genetics and Biotechnology faculty. At least one member must be from a department other than the one that administers the student's major.

The student is required to complete courses, learn research methodologies, and conduct dissertation research pertinent to the plant species under study. The student must complete at least 12 credits in 800–level plant breeding and genetics courses including four credits of Horticulture 892, and two core courses as specified by the Plant Breeding, Genetics and Biotechnology faculty. One semester of teaching experience is also required.

The student's program is subject to review by the Plant Breeding, Genetics and Biotechnology faculty. The degree is conferred upon recommendation of the department, the Coordinator of the Plant Breeding, Genetics and Biotechnology Program, and the Dean of the college.

GRADUATE SPECIALIZATION in ENVIRONMENTAL TOXICOLOGY

The College of Agriculture and Natural Resources, the College of Natural Science, and the College of Veterinary Medicine administer the Graduate Specialization in Environmental Toxicology. The College of Agriculture and Natural Resources is the primary administrative unit.

The specialization is available as an elective to students who are enrolled in master's degree programs in the departments of Animal Science, Community Sustainability, Crop and Soil Sciences, Entomology, Fisheries and Wildlife, Food Science and Human Nutrition, Geological Sciences, Pathobiology and Diagnostic Investigation, Plant, Soil and Microbial Sciences, and Zoology. The specialization is designed for students who are interested in combining study in their disciplines with study in environmental toxicology, and in applying their knowledge to solve environmental problems. A faculty member who is in the department that administers the student's degree program and who is associated with the Specialization in Environmental Toxicology will serve as the student's academic advisor for the specialization. The academic advisor will assist the student in planning a program of study that is related to the student's interests, capabilities, and professional goals. With the approval of the department and college that administer the student's degree program, the courses that are used to satisfy the requirements for the specialization may also be used to satisfy the requirements for the master's degree.

Requirements for the Graduate Specialization in Environmental Toxicology

The student's program of study must be approved by the student's academic advisor for the specialization. The student must meet the requirements specified below:

		CREDITS
1.	Have a grade–point average of at least 3.00 in the courses that are used to satisfy the requirements for the specialization.	
2.	Complete the following courses (6 credits):	
	CSUS846 Law of Environmental Regulation	3
	PHM 450 Introduction to Chemical Toxicology	3
3.	Complete two courses from any of the five categories listed below (6 to 8 credits):	
	Environmental Dynamics	
	CSS 455 Environmental Pollutants in Soil and Water	3
	ENE 481 Environmental Chemistry: Equilibrium Concepts	3
	ENE 801 Dynamics of Environmental Systems	3
	ENE 821 Groundwater Hydraulics	3
	GLG 421 Environmental Geochemistry	4
	GLG 821 Aqueous Geochemistry	3
	MMG425 Microbial Ecology	3
	ZOL 897 Ecosystem Ecology and Global Change	4
	Economics, Policy, and Law	
	AFRE 810 Institutional and Behavioral Economics	3
	AFRE 829 Economics of Environmental Resources	3
	CSUS 425 Environmental Impact Assessment	4
	Waste Management	
	ENE 483 Water and Wastewater Treatment	3
	ENE 487 Microbiology for Environmental Science and Engineering	3
	ENE 804 Biological Processes in Environmental Engineering	3
	Analytical Chemistry	
	CEM 835 Advanced Analytical Chemistry II	3

CEM 836 Separation Science 3
CEM 845 Structure and Spectroscopy of Organic Compounds 3
Mechanisms of Toxicity
ANS 407 Food and Animal Toxicology 3
BMB 960 Selected Topics in Biochemistry I 3
FSC 807 Advanced Food Toxicology 3
Biochemistry and Molecular Biology 960 may be counted toward the requirements for the specialization only when the topic deals with environmental toxicology.

4. Attend a minimum of six seminars in environmental toxicology.

GRADUATE SPECIALIZATION IN FISH AND WILDLIFE DISEASE ECOLOGY AND CONSERVATION MEDICINE

The Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine is designed to provide students with improved understanding of the likely consequences of increased contact between fish and wildlife, domestic animals and human populations for emergence and spread of infectious diseases. Students will gain a sound understanding of the basis of fish and wildlife disease, and an appreciation of the diagnostic and surveillance tools needed to move toward effective disease control among wild populations and ecosystems. Students will also obtain the skills that will enable them to work effectively within interdisciplinary and interagency teams to develop disease surveillance, control, and prevention plans.

The specialization which is administered by the Department of Fisheries and Wildlife and the College of Agriculture and Natural Resources, is available as an elective to master's and doctoral students in the College of Agriculture and Natural Resources, the College of Natural Science, and the College of Veterinary Medicine. Students enrolled in Plan A (thesis) master's programs are encouraged to develop thesis topics which integrate their chosen discipline with the interdisciplinary focus integral to this specialization. It is designed for students who are interested in combining study in their disciplines with the study of fish and wildlife disease ecology and in applying their knowledge to the management of emerging and recurring disease in fish and wildlife populations and in ecosystems.

With the approval of the department or school and college 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 graduate degree program. The student's program of study must be approved by the student's academic advisor for the specialization.

Requirements for the Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine

The student must:

1. Complete all of the following courses (10 credits): CREDITS
   FW 423 Principles of Fish and Wildlife Disease 3
   FW 423L Principles of Fish and Wildlife Disease Laboratory 1
   FW 463 Wildlife Disease Ecology 3
   FW 821 Conservation Medicine 3
2. Students must provide evidence of background and/or education in epidemiology and or quantitative methods. Typically, this background or education will be in the form of successful completion of one semester-long course in each of these areas. Course work taken prior to entering the graduate specialization can be used to satisfy this requirement. Waiver of this requirement requires review by the advisor for the specialization.
3. Master's and doctoral students will complete a thesis or dissertation reflecting the integration of the student's discipline.

GRADUATE SPECIALIZATION in GENDER, JUSTICE, and ENVIRONMENTAL CHANGE

The Graduate Specialization in Gender, Justice, and Environmental Change is administered by the College of Agriculture and Natural Resources and the College of Social Science. The primary administrative unit for this specialization is the College of Agriculture and Natural Resources.

The Graduate Specialization in Gender, Justice, and Environmental Change is available as an elective for students who are enrolled in master's and doctoral programs at Michigan State University. The goal of this program is to provide graduate students from different academic backgrounds with analytical and methodological tools to address environmental issues from the perspectives of gender relations and social justice. Students will be encouraged to develop an understanding of global perspectives on environmental issues in view of local-global linkages. The program will prepare students to foster the growth of research, service, and interdisciplinary collaboration in the fields of gender and environmental studies and to increase knowledge of the relationships between gender and domestic and international environmental issues.

Persons who are interested in the specialization must contact the advisor for the Graduate Specialization in Gender, Justice, and Environmental Change in the College of Agriculture and Natural Resources. To be admitted to the specialization, a student must have been admitted to a graduate program at Michigan State University.

With the approval of the department and college that administer 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 a master's or doctoral degree.

Requirements for the Specialization in Gender, Justice, and Environmental Change

The student must complete a total of 12 credits:

1. Both of the following courses: CREDITS
   ANP 859 Gender, Justice, and Environmental Change: Methods and Application 3
   CSUS858 Gender, Justice, and Environmental Change: Issues and Concepts 3
2. Two courses relevant to gender, justice and environmental change. These courses will be selected, with advisor approval, after consideration of a recommended list of courses, furnished by the advisor, from such fields as agricultural economics, anthropology, forestry, fisheries and wildlife, political science, resource development, sociology, social work, and women's studies.
   a. Policy course 3
   b. Elective course 3

INTERDEPARTMENTAL GRADUATE SPECIALIZATIONS in ENVIRONMENTAL AND RESOURCE ECONOMICS

The interdepartmental graduate specialization in environmental and resource economics is an elective for students in all graduate majors. The specialization is designed to:

1. provide an opportunity for graduate students to obtain advanced training in the field of environmental and natural resource economics.
2. develop an intellectual environment, which will foster the growth of research and public service in the area of environmental and natural resource economics.
3. foster an understanding among graduate students of the career opportunities and professional responsibilities in the fields of environmental and natural resource economics.
4. increase public awareness of environmental and natural resource problems and alternative solutions.

Students who elect this graduate specialization seek a high degree of proficiency in the economic analysis of environmental and natural resource problems. The specialization is suitable for graduate students who intend to specialize in this area of economic analysis, as well as for those who may have a departmental major in a non-economic aspect of the environment and natural resources, but who want to deepen their understanding of how economics influences their major area of study.

The College of Agriculture and Natural Resources and the College of Social Science jointly administer the specialization. The College of Agriculture and Natural Resources is the primary administrative unit. The faculty who participate in this specialization are drawn from the departments of Agricultural, Food, and Resource Economics; Community, Agriculture, Recreation and Resource Studies, Economics; Fisheries and Wildlife; and Forestry.

Core faculty are selected by the chairpersons of the six participating departments. Each department designates one core faculty member to serve on a Coordinating Committee for the Specialization in Environmental and Resource Economics. The Coordinating Committee oversees the policies and program requirements adopted by the core faculty. Faculty members who comprise the core faculty may change with the mutual consent of the chairpersons of the departments, upon recommendation of the Coordinating Committee.

Requirements for the Specializations in Environmental and Resource Economics

Master's Students: The specialization consists of the completion of approximately 18 credits of resource economics and methods courses specified by the coordinating committee and approved by the core faculty. Credits in courses taken for the specialization may be counted toward the requirements for the student's major at the discretion of the major department. At least one core faculty member serves on the student's guidance committee.

Doctoral Students: The specialization consists of the completion of approximately 24 credits of resource economics and methods courses, and passing a written examination. Course work is specified by the coordinating committee and approved by the core faculty. The examination committee consists of three core faculty members selected by the Coordinating Committee. Credits in courses taken to meet the requirements of the specialization may be used for a student's major at the discretion of the student's major department. At least one core faculty member serves on the student's guidance committee.

AGRICULTURE and NATURAL RESOURCES EXPLORATORY UNDERGRADUATE PROGRAM

An Agriculture and Natural Resources exploratory program is offered for students selecting the College of Agriculture and Natural Resources but desiring to delay their choice of a specific field until a later date. The program is basic to all majors offered by the College of Agriculture and Natural Resources and permits the student flexibility with respect to major choice. Students may remain in this exploratory program until they attain junior standing, or they may select major preferences at any time prior to becoming juniors.

DEPARTMENT of AGRICULTURAL, FOOD, and RESOURCE ECONOMICS

Chad Coti, Chairperson

The department administers highly successful undergraduate and graduate programs in applied economics and management with a focus on agriculture, food, and natural resources.

UNDERGRADUATE PROGRAMS

The department offers three undergraduate majors: agribusiness management, environmental economics and management, and food industry management. These majors emphasize the application of business and social sciences to the management of public and private sector organizations. Each major is built on a liberal education base with a core of professional courses and sufficient electives for students and their advisors to tailor individualized programs.

AGRIBUSINESS MANAGEMENT

The agribusiness management major is designed for students who are interested in careers with agricultural input supply, agricultural production, commodity assembly and processing, and agricultural marketing organizations. The program, which focuses on the managerial functions

performed by organizations throughout the agribusiness sector, provides a system–wide perspective of managerial problems confronting such organizations. Faculty who are associated with the program maintain close relationships with agribusiness companies. Those relationships benefit students who seek information about careers, scholarships, and employment in the field.

Requirements for the Bachelor of Science Degree in Agribusiness Management

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 Agribusiness Management.
   The University's Tier II Writing Requirement for the Agribusiness Management major is met by completing one of the following courses: Agricultural Food and Resource Economics 445 or 465. Those courses are referenced in item 3. below.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.
   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
   Students must achieve a grade of at least 2.0 or higher in each AFRE course referenced in items 3. a. and in all courses taken to fulfill requirements 3. b., 3. c., and 3.d.
3. The following requirements for the major:

			CREDITS
a. All of the following courses (38 credits):			
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	130	Farm Management I	3
AFRE	203	Data Analysis for the Agri-Food System	3
AFRE	206	World Food, Population and Poverty	3
AFRE	210	Professional Seminar in Agricultural, Food, and Resource Economics	1
AFRE	222	Agribusiness and Food Industry Sales (W)	3
AFRE	232	Commodity Marketing I	3
AFRE	240	Food Product Marketing	3
AFRE	265	Ecological Economics	3
AFRE	410	Advanced Professional Seminar in Agricultural Food and Resource Economics	1
AFRE	435	Financial Management in the Agri-Food System	3
EC	201	Introduction to Microeconomics	3
EC	202	Introduction to Macroeconomics	3
SCM	304	Survey of Supply Chain Management	3
b. Three of the following courses (9 credits):			
AFRE	224	Information and Market Intelligence in the Agri-Food Industry	3
AFRE	300	Public Policy Issues in the Agri-Food System	3
AFRE	315	Labor and Personnel Management in the Agri-Food System	3
AFRE	322	Organization of the Agri-Food Systems	3
AFRE	327	Global Agri-Food Industries and Markets	3
AFRE	330	Farm Management II	3
AFRE	432	Commodity Marketing II	3
AFRE	445	Strategic Management for Food and Agribusiness Firms (W)	3
AFRE	465	Corporate Environmental Management (W)	3
AFRE	490	Independent Study in Agricultural Food and Resource Economics	3
AFRE	493	Professional Internship in Agricultural Food and Resource Economics	3

   A study abroad or independent study experience may also fulfill part of this requirement through enrollment in AFRE 490 with approval by the department.
   Agricultural Food and Resource Economics 300, 330 or 432 may be used to fulfill requirement 3.b. if not used to fulfill requirement 3.d.

c. One of the following courses (3 credits):			
AFRE	445	Strategic Management for Food and Agribusiness Firms (W)	3
AFRE	465	Corporate Environmental Management (W)	3
d. One of the following courses (3 credits):			
AFRE	300	Public Policy Issues in Agri-Food System	3
AFRE	330	Farm Management II	3
AFRE	432	Commodity Marketing II	3
e. One of the following courses (3 or 4 credits):			
AFRE	303	Managerial Economics	3
EC	301	Intermediate Microeconomics	3
f. One of the following courses (3 or 4 credits):			
STT	200	Statistical Methods	3
STT	201	Statistical Methods	4
STT	315	Introduction to Probability and Statistics for Business	3

   g. Complete 6 credits in sciences related to agricultural production and processing, as approved by the department. It is recommended that these credits be from the same discipline.

FOOD INDUSTRY MANAGEMENT

The food industry management major is designed for students who are interested in careers in the food industry. Graduates of this major enter managerial positions with food wholesalers-distributors and retailers as well as sales, account management, and production supervision positions with food manufacturers. The program provides a system-wide perspective of managerial problems confronting firms in the food industry, recognizes the increasing interdependence among such firms and focuses on creating consumer value. Faculty who are associated with the program maintain close relationships with food companies and trade associations, bring practical applications and examples to the classroom and provide current information about career and scholarship opportunities.

Requirements for the Bachelor of Science Degree in Food Industry Management

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 Food Industry Management.
   The University's Tier II Writing Requirement for the Food Industry Management major is met by completing Agricultural, Food and Resource Economics 445. This course is referenced in item 3. below.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.
   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
   Students must achieve a grade of at least 2.0 or higher in each AFRE course referenced in items 3. a. and in courses taken to fulfill requirements 3. b. and 3. c.
3. The following requirements for the major:

			CREDITS
a. All of the following courses (38 credits):			
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	203	Data Analysis for the Agri-Food System	3
AFRE	206	World Food, Population and Poverty	3
AFRE	210	Professional Seminar in Agricultural, Food, and Resource Economics	1
AFRE	222	Agribusiness and Food Industry Sales	3
AFRE	240	Food Product Marketing	3
AFRE	265	Ecological Economics	3
AFRE	340	Food Marketing Research and Analytics	3
AFRE	410	Advanced Professional Seminar in Agricultural Food and Resource Economics	1
AFRE	440	Food Marketing Management	3
AFRE	445	Strategic Management for Food and Agribusiness Firms (W)	3
EC	201	Introduction to Microeconomics	3
EC	202	Introduction to Macroeconomics	3
SCM	304	Survey of Supply Chain Management	3
b. Three of the following courses (9 credits):			
AFRE	224	Information and Market Intelligence in the Agri-Food Industry	3

AFRE 232 Commodity Marketing I 3
AFRE 300 Public Policy Issues in the Agri-Food System 3
AFRE 315 Labor and Personnel Management in the Agri-Food System 3
AFRE 322 Organization of the Agri-Food Systems 3
AFRE 327 Global Agri-Food Industries and Markets 3
AFRE 435 Financial Management in the Agri-Food System 3
AFRE 465 Corporate Environmental Management (W) 3
AFRE 490 Independent Study in Agricultural Food and Resource Economics 3
AFRE 493 Professional Internship in Agricultural Food and Resource Economics 3

A study abroad or independent study experience may also fulfill part of this requirement through enrollment in AFRE 490 with approval by the department.

Agricultural Food and Resource Economics 435 or 465 may be used to fulfill requirement 3.b. if not used to fulfill requirement 3.c.

c. One of the following courses (3 credits):
AFRE 435 Financial Management in the Agri-Food System 3
AFRE 465 Corporate Environmental Management (W) 3

d. One of the following courses (3 credits):
ACC 201 Principles of Financial Accounting 3
ACC 230 Survey of Accounting Concepts 3
AFRE130 Farm Management I 3
FI 320 Introduction to Finance 3

e. One of the following courses (3 or 4 credits):
STT 200 Statistical Methods 3
STT 201 Statistical Methods 4
STT 315 Introduction to Probability and Statistics for Business 3

f. One of the following courses (3 credits):
AFRE303 Managerial Economics 3
EC 301 Intermediate Microeconomics 3

g. Complete 6 credits in sciences related to food production and processing, as approved by the department. It is recommended that these credits be from the same discipline.

ENVIRONMENTAL ECONOMICS AND MANAGEMENT

Environmental Economics and Management prepares students for careers that require consideration of environmental sustainability and economic performance goals for the public sector and businesses. The business component has a particular focus on resource, agricultural, and food industries, as these have strong environmental linkages. The major develops skills in environmental economics and policy analysis as well as core business disciplines such as accounting, marketing, and supply chain management. Business skills and knowledge are developed to help manage or create environmentally and socially responsive business organizations that also deliver shareholder value. The major prepares students for sustainability related employment opportunities with state and federal government agencies, non-profit organizations, the agricultural and food industry, and consulting firms. The major also offers students the opportunity to prepare for graduate study in environmental economics and policy or business programs.

Requirements for the Bachelor of Science Degree in Environmental Economics and Management

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 Environmental Economics and Management.

   The University's Tier II writing requirement for the Environmental Economics and Management major is met by completing Agricultural Food and Resource Economics 465. That course is referenced in item 3. a. below.

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

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

   Students must achieve a grade of at least 2.0 or higher in each AFRE course referenced in items 3. a. and in courses taken to fulfill requirements 3. b. and 3. c.

3. The following requirements for the major:

CREDITS

a. All of the following courses (38 credits):
AFRE 100 Decision-making in the Agri-Food System 3
AFRE 203 Data Analysis for the Agri-Food System 3
AFRE 206 World Food, Population and Poverty 3
AFRE 210 Professional Seminar in Agricultural, Food, and Resource Economics 1
AFRE 222 Agribusiness and Food Industry Sales (W) 3
AFRE 240 Food Product Marketing 3
AFRE 265 Ecological Economics 3
AFRE 360 Environmental Economics 3
AFRE 410 Advanced Professional Seminar in Agricultural Food and Resource Economics 1
AFRE 460 Natural Resource Economics 3
AFRE 465 Corporate Environmental Management (W) 3
EC 201 Introduction to Microeconomics 3
EC 202 Introduction to Macroeconomics 3
SCM 304 Survey of Supply Chain Management 3

b. Three of the following courses (9 or 10 credits):
AFRE 224 Information and Market Intelligence in the Agri-Food Industry 3
AFRE 300 Public Policy Issues in the Agri-Food System 3
AFRE 315 Labor and Personnel Management in the Agri-Food System 3
AFRE 322 Organization of the Agri-Food Systems 3
AFRE 327 Global Agri-Food Industries and Markets 3
AFRE 435 Financial Management in the Agri-Food System 3
AFRE 445 Strategic Management for Food and Agribusiness Firms (W) 3
AFRE 490 Independent Study in Agricultural Food and Resource Economics 3
AFRE 493 Professional Internship in Agricultural Food and Resource Economics 3
CSUS 354 Water Resources Management 3
CSUS 465 Environmental and Natural Resource Law 3
EC 450 Economics of Environmental Policy (W) 3
FOR 419 Applications of Geographic Information Systems to Natural Resource Management 4

A study abroad or independent study experience may also fulfill part of this requirement through enrollment in AFRE 490 with approval by the department.

Agricultural Food and Resource Economics 435 or 445 may be used to fulfill requirement 3.b. if not used to fulfill requirement 3.c.

c. One of the following courses (3 credits):
AFRE 435 Financial Management in the Agri-Food System 3
AFRE 445 Strategic Management for Food and Agribusiness Firms (W) 3

d. One of the following courses (3 credits):
ACC 201 Principles of Financial Accounting 3
ACC 230 Survey of Accounting Concepts 3
AFRE130 Farm Management I 3
FI 320 Introduction to Finance 3

e. One of the following courses (3 or 4 credits):
STT 200 Statistical Methods 3
STT 201 Statistical Methods 4
STT 315 Introduction to Probability and Statistics for Business 3

f. One of the following courses (3 credits):
AFRE 303 Managerial Economics 3
EC 301 Intermediate Microeconomics 3

g. Complete 6 credits in sciences related to sustainability and the environment, as approved by the department. It is recommended that these credits be from the same discipline.

MINOR IN AGRIBUSINESS MANAGEMENT

The Minor in Agribusiness Management is designed to serve students with majors in other fields who are interested in careers in agribusiness. The primary educational objective of the minor is to provide students with a fundamental knowledge of business management in relation to agribusiness firms.

The minor is available as an elective to all students who are enrolled in bachelor's degree programs at Michigan State University other than the Bachelor of Science degree program with a major in agribusiness management. The minor is administered by the Department of Agricultural, Food, and Resource Economics.

At least 9 credits counted towards the requirements for this minor must be unique. Unique credits must not be used to fulfill another university, college, or major requirement in the student's program.

Requirements for the Minor in Agribusiness Management

The student must complete 15 credits from the following:

			CREDITS
1. Both of the following courses (6 credits):			
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	203	Data Analysis for the Agri-Food System	3
2. One of the following courses (3 credits):			
AFRE	130	Farm Management I	3
AFRE	232	Commodity Marketing	3
3. Two of the following courses including at least one course at the 300-level or above (6 credits):			
AFRE	130	Farm Management I	3
AFRE	222	Agribusiness and Food Industry Sales	3
AFRE	232	Commodity Marketing	3
AFRE	300	Public Policy Issues in the Agri-Food System	3
AFRE	303	Managerial Economics	3
AFRE	322	Organization of the Agri-Food Systems	3
AFRE	327	Global Agri-Food Industries and Markets	3
AFRE	330	Farm Management II	3
AFRE	432	Commodity Marketing II	3
AFRE	435	Financial Management in the Agri-Food System	3
AFRE	490	Independent Study in Agricultural Food and Resource Economics	3

Agricultural Food and Resource Economics 130 or 232 may be used to fulfill requirement 3. if not used to fulfill requirement 2.

MINOR IN ENVIRONMENTAL ECONOMICS

The Minor in Environmental Economics is designed to serve students who are interested in the application of economics to environmental issues. The educational objectives of the minor are to:

1. Introduce students to the concepts and principles of environmental economics.
2. Help students to develop the skills necessary to analyze environmental and natural resource issues.
3. Help students to understand the economic dimensions of the many environmental issues facing society.

The minor is available as an elective to all students who are enrolled in bachelor's degree programs at Michigan State University other than the Bachelor of Science degree in Environmental Economics and Management. The minor is administered by the Department of Agricultural, Food, and Resource Economics.

At least 9 credits counted towards the requirements for this minor must be unique. Unique credits must not be used to fulfill another university, college, or major requirement in the student's program.

Requirements for the Minor in Environmental Economics

The student must complete a minimum of 15 credits:

			CREDITS
1. All of the following courses (9 credits):			
AFRE	203	Data Analysis for the Agri-Food System	3
AFRE	265	Ecological Economics	3
AFRE	360	Environmental Economics	3
2. One of the following courses (3 credits):			
AFRE	460	Natural Resource Economics	3
AFRE	465	Corporate Environmental Management (W)	3
3. One of the following courses (3 or 4 credits):			
AFRE	303	Managerial Economics	3
AFRE	460	Natural Resource Economics	3
AFRE	465	Corporate Environmental Management (W)	3
CSUS	354	Water Resources Management	3
CSUS	465	Environmental and Natural Resource Law	3
EC	450	Economics of Environmental Policy (W)	3
FOR	419	Applications of Geographic Information Systems	4

Agricultural Food and Resource Economics 460 or 465 may be used to fulfill requirement 3. if not used to satisfy requirement 2.

MINOR IN FOOD INDUSTRY MANAGEMENT

The Minor in Food Industry management is designed to serve students with majors in other fields who are interested in careers in the food industry. The primary educational objective of the minor is to provide students with a fundamental knowledge of business management in relation to the food industry.

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 Science degree program with a major in food industry management. The minor is administered by the Department of Agricultural, Food, and Resource Economics.

At least 9 credits counted towards the requirements for this minor must be unique. Unique credits must not be used to fulfill another university, college, or major requirement in the student's program.

Requirements for the Minor in Food Industry Management

The student must complete 15 credits from the following:

			CREDITS
1. All of the following courses (9 credits):			
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	203	Data Analysis for the Agri-Food System	3
AFRE	240	Food Product Marketing	3
2. One of the following courses (3 credits):			
AFRE	340	Food Marketing Research and Analytics	3
AFRE	440	Food Marketing Management	3
3. One of the following courses (3 credits):			
AFRE	222	Agribusiness and Food Industry Sales	3
AFRE	300	Public Policy Issues in the Agri-Food System	3
AFRE	303	Managerial Economics	3
AFRE	322	Organization of the Agri-Food Systems	3
AFRE	327	Global Agri-Food Industries and Markets	3
AFRE	340	Food Marketing Research and Analytics	3
AFRE	440	Food Marketing Management	3

AFRE	445	Strategic Management for Food and Agribusiness Firms (W)	3
AFRE	490	Independent study in Agricultural Food and Resource Economics	3

Agricultural Food and Resource Economics 340 and 440 may be used to fulfill requirement 3. if not used to fulfill requirement 2.

GRADUATE STUDY

The Department of Agricultural, Food, and Resource Economics offers Master of Science and Doctor of Philosophy degree programs in agricultural, food and resource economics. The courses and programs are designed to help students become thoroughly grounded in the concepts and tools of economic analysis and management, and in using them to solve applied problems in areas such as development economics, environmental and resource economics, agricultural and food economics, and food and agribusiness management.

The department participates in several graduate level specializations.

Graduate students who are enrolled in the Department of Agricultural, Food, and Resource Economics may elect a specializations in resource economics (M.S. and Ph.D.). For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Resource Economics*.

AGRICULTURAL, FOOD and RESOURCE ECONOMICS

Master of Science

The master's programs in agricultural, food and resource economics may be designed to serve either as final preparation for professional employment or as the foundation for a doctoral program.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Applications to the Master of Science Degree in Agricultural, Food and Resource Economics are evaluated by an admissions committee formed by the Department Chairperson and chaired by the Graduate Program Director.

Several criteria are used to evaluate applications including:

1. Academic preparation including review of previous degrees and grades, Graduate Record Examination (GRE), and Test of English as a Foreign Language (TOEFL) scores.
2. Letters of recommendation.
3. Match between the applicant's background, interests, and educational objectives, and the department's research, teaching, and/or outreach programs.
4. The applicant's contribution to the diversity and balance of the department's graduate study body.

Many undergraduate programs provide background for graduate study in agricultural, food and resource economics. However, a student with inadequate background in areas deemed important to the program of study may be required to complete collateral courses in addition to the minimum credit requirements for the degree and may be admitted on a provisional status until some deficiencies are remedied. All applicants for admission to graduate degree programs in agricultural, food and resource economics are required to submit scores for the General Test of the Graduate Record Examination.

Additional details on admission requirements and procedures are outlined on the department Web site at *http://www.canr.msu.edu/afre/graduate/applying*.

Requirements for the Master of Science Degree in Agricultural, Food and Resource Economics

CREDITS

The student may elect either Plan A (with thesis) or Plan B (non-thesis research paper). The student's plan of study should be approved by the department prior to the beginning of the second year of enrollment in the program.

A total of 30 credits is required for the degree under Plan A, and a total of 33 credits is required for the degree under Plan B.

Requirements for Both Plan A and Plan B:

1. Complete a minimum of 3 credits of microeconomic theory in AFRE 805 or its equivalent.
2. Complete a minimum of 9 credits of quantitative methods by enrollment in AFRE 801 and AFRE 802, or equivalent, and 3 credits of an elective, usually AFRE 835. A grade point average of 3.0 or greater is required in all three quantitative methods courses.
3. Complete an additional 12 credits of advanced course work at the 800- or 900-level, at least 9 credits must be AFRE courses.
4. Pass a final oral examination at which the student presents their thesis or research paper results.
5. Have a grade point average of at least 3.0 in the student's approved course program before the student can be certified for graduation. Collateral courses are not included in this calculation.

Additional Requirements for Plan A:

1. Complete 6 credits of AFRE 899 Master's Thesis Research.

Additional Requirements for Plan B:

1. Complete 3 credits of AFRE 898 Master's Research.
2. Complete 6 credits within or outside AFRE in consultation and approved by the Graduate Program Director.

Guidance Committee

New students are assigned a temporary major professor by the Graduate Program Director, in consultation with the student and faculty member. The student is responsible for assembling a long-term major professor and guidance committee via consultation with faculty and, if desired, the Graduate Program Director. Students must have a major professor and guidance committee by the end of their second semester. The guidance committee consists of three or more Michigan State University regular faculty members. A majority of the guidance committee members must have appointments in the Department of Agricultural, Food and Resource Economics.

Doctor of Philosophy

The Doctor of Philosophy degree in Agricultural, Food, and Resource Economics equips students with a strong foundation in microeconomic theory, econometric methods, and analytical tools for applied microeconomics. A major field provides specialized training in one of three major areas of

emphasis. Graduates proceed to careers in academia, research institutes, government, and business.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Applications to the Doctor of Philosophy Degree in Agricultural, Food and Resource Economics are evaluated by an admissions committee formed by the Department Chairperson and chaired by the Graduate Program Director.

Several criteria are used to evaluate applications including:

1. Academic preparation including review of previous degrees and grades, Graduate Record Examination (GRE), and Test of English as a Foreign Language (TOEFL) scores.
2. Letters of recommendation.
3. Match between the applicant's background, interests, and educational objectives, and the department's research, teaching, and/or outreach programs.
4. The applicant's contribution to the diversity and balance of the department's graduate study body.

Additional details on admission requirements and procedures are outlined on the department Web site at *http://www.canr.msu.edu/afre/graduate/applying*.

Requirements for the Doctor of Philosophy Degree in Agricultural, Food and Resource Economics

A total of 61 credits is required for the degree. The student must:

1. Complete all of the following core courses (16 credits):

			CREDITS
AFRE	900	Applied Microeconomics II	3
EC	812A	Microeconomics I and its Mathematical Foundations	4
EC	812B	Microeconomics II	3
EC	820A	Econometrics IA	3
EC	820B	Econometrics IB	3

   EC 812A, EC 812B, EC 820A, and EC 820B must be taken during the student's first academic year of doctoral study, and AFRE 900 must be taken in the fall semester of their second year. To be qualified to proceed in the AFRE Ph.D. program, grades of 3.5 or better are required in at least two of the five core courses (EC 812A, EC 812B, EC 820A, EC 820B, and AFRE 900), with a 3.0 minimum grade required in each course. Retaking a course to meet these requirements is not allowed.
2. Complete 9 credits in one of three major fields in Agricultural, Food and Resource Economics: development economics, environmental and resource economics, or food and agricultural economics. A 3.0 minimum grade is required in each course used to establish the student's major field and the student's cumulative grade-point average for their major field courses must be greater than 3.0 (i.e., a grade of 3.5 or better is required in at least one of the student's three major field courses).
3. Complete an additional 12 credits of advanced course work at the 800- or 900-level, at least 6 credits must be AFRE courses.
4. Complete a minimum of 24 credits of AFRE 999 Doctoral Dissertation Research.
5. Pass the comprehensive examination no later than the end of the third year.
6. Present and obtain formal approval for the proposed dissertation research by the end of the fourth year.
7. Pass a final oral examination at which the student presents their dissertation results.
8. Attend at least 6 AFRE (or joint AFRE-EC) seminars in any single academic year before the end of the fourth year.
9. Have a grade point average of at least 3.0 in the student's approved course program before the student can be certified for graduation. Collateral courses are not included in this calculation.

Guidance Committee

New students are assigned a temporary major professor by the Graduate Program Director, in consultation with the student and faculty member. The student is responsible for assembling a long-term major professor and guidance committee via consultation with faculty and, if desired, the Graduate Program Director. Students must have a major professor and guidance committee by the end of their third semester. The guidance committee consists of four or more Michigan State University regular faculty members. A majority of the guidance committee members must have appointments in the Department of Agricultural, Food and Resource Economics.

DEPARTMENT of ANIMAL SCIENCE

Catherine W. Ernst, Chairperson

Animal Science is an exciting field that has applications to a wide range of animal species and provides opportunities from production through agribusiness, processing, research, and human animal interaction. Animal Science provides a solid foundation for diverse careers as well as professional schools such as human and veterinary medicine, or graduate school. A degree in Animal Science at Michigan State University prepares students well for many career paths.

UNDERGRADUATE PROGRAM

The undergraduate program in animal science is designed to prepare students for a variety of careers by providing a strong basic science foundation paired with practical animal experience gained through the multiple farm facilities near campus. Graduates may be employed in research, extension, agribusiness, finance, marketing, public relations, event or association management, farm ownership, and more. Graduates often attend veterinary or graduate school as well.

All animal science students must complete a set of required core courses that include anatomy and physiology, nutrition, genetics, and management. These courses are taught using beef cattle, companion animals, dairy cattle, horses, poultry, and swine. Additional courses are then added to allow students to personalize their program of study. Scientific principles of biology and animal science are key components of the program although the animal science major also provides enough flexibility for students to choose a path that meets their needs and interest areas. Students choose from one of the following concentrations as they plan their degree program: animal industry, companion and exotic animal biology, dairy industry, or animal biology/preveterinary.

The *animal industry concentration* is designed to prepare students for careers in managing animal operations. Marketing, sales, and production of animals and animal products offer numerous employment opportunities. The *companion and exotic animal biology concentration* prepares

students for careers in the areas of small animal nutrition, pet food sales, and captive and small animal management. Students may also use their elective credits to complete the preveterinary requirements and apply to MSU's College of Veterinary Medicine. The *dairy industry concentration* is designed to prepare students for careers in the dairy industry. Potential career opportunities include operating and managing dairy operations and working for dairy allied businesses in the areas of nutrition, reproduction, health, finance, and marketing. The *animal biology/preveterinary concentration* is designed for students who are interested in an advanced degree in animal science or a career in veterinary medicine. The requirements for admission to MSU's College of Veterinary Medicine are included in the requirements for this concentration. Using electives, students may be able to complete requirements for other veterinary schools. Each veterinary school requires different courses for admission. It is the student's responsibility to assess requirements and transferability of courses to the desired veterinary school.

Students who are enrolled in the Bachelor of Science degree program with a major in animal science may elect a Minor in Plant, Animal and Microbial Biotechnology. For additional information, refer to the *Minor in Plant, Animal and Microbial Biotechnology* statement.

Requirements for the Bachelor of Science Degree in Animal 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 Animal Science.

   The University's Tier II writing requirement for the Animal Science major is met by completing one of the following courses: Animal Science 301, 313, 314, 409, or 435. Those courses are referenced in item 3. a. below.

   Students who are enrolled in the Animal Science major leading to the Bachelor of Science degree in the Department of Animal Science may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 161 and 171, Chemistry 141, and Chemistry 143 or 251. The completion of Biological Science 171 satisfies the laboratory requirement. Biological Science 161 and 171, Chemistry 141, and Chemistry 143 or 251 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:

			CREDITS
a. All of the following courses (21 credits):			
	ANS 101	Professional Development in Animal Science I	1
	ANS 110	Introductory Animal Agriculture	3
	ANS 110L	Introductory Animal Agriculture Laboratory	1
	ANS 210	Introduction to Disciplines in Animal Agriculture	3
	ANS 301	Professional Development in Animal Science II	3
	ANS 401	Ethical Issues in Animal Agriculture	1
	BS 161	Cell and Molecular Biology	3
	BS 171	Cell and Molecular Biology Laboratory	2
	CEM 141	General Chemistry	4
b. One of the following courses (3 or 4 credits):			
	STT 200	Statistical Methods	3
	STT 201	Statistical Methods	4
	STT 231	Statistics for Scientists	3
	STT 421	Statistics I	3
	STT 464	Statistics for Biologists	3
c. One of the following courses (3 or 4 credits):			
	CEM 143	Survey of Organic Chemistry	4
	CEM 251	Organic Chemistry I	3
d. Two of the following introductory management courses (6 credits):			
	ANS 134	Dairy Production I	3
	ANS 201	Animal Products	3
	ANS 222	Introductory Beef Cattle Management	3
	ANS 234	Dairy Production II	3
	ANS 242	Introductory Horse Management	3
	ANS 252	Introduction to Management of Avian Species	3
	ANS 262	Introductory Sheep Management	3
	ANS 272	Introductory Swine Management	3
	ANS 282	Companion Animal Biology and Management	3
e. A minimum of 14 credits from the following introductory discipline courses:			
	ANS 305	Applied Animal Behavior	3
	ANS 305L	Applied Animal Behavior Laboratory	1
	ANS 307	Animal Reproduction	3
	ANS 309	Animal Health and Disease Management	3
	ANS 313	Principles of Animal Feeding and Nutrition (W)	4
	ANS 314	Genetic Improvement of Domestic Animals	4
	ANS 315	Anatomy and Physiology of Farm Animals	4
	ANS 407	Food and Animal Toxicology	3
f. One of the following advanced management courses (3 credits):			
	ANS 334	Dairy Management I	3
	ANS 422	Advanced Beef Cattle Feedlot Management	3
	ANS 442	Advanced Horse Management	3
	ANS 472	Advanced Swine Management	3
	ANS 482	Advanced Companion Animal Management	3
	FSC 432	Food Processing: Dairy Foods	3
	FSC 433	Food Processing: Muscle Foods	3
g. A minimum of 2 credits in experiential learning:			
	ANS 300A	Advanced Livestock Judging	2
	ANS 300C	Dairy Cattle Judging Team	2
	ANS 300D	Advanced Horse Judging	2
	ANS 300E	Animal Welfare Judging	2
	ANS 300F	Dairy Challenge Experiences	2
	ANS 480	Animal Systems in International Development	3
	ANS 492	Undergraduate Research in Animal Science	3
	ANS 493	Professional Internship in Animal Science	3
A minimum of 3 credits in a department-approved Education Abroad program			

h. One of the following concentrations (20 to 40 credits):

Animal Industry (20 to 24 credits):

1. The following courses (3 credits):

ANS 201	Animal Products	3

ANS 201 may not be used to fulfill requirement 3.d. above.

2. One of the following courses (2 or 3 credits):

AFRE203	Data Analysis for the Agri-Food System	3
CSS 110	Computer Applications in Agronomy	2

3. One of the following courses (3 credits):

AFRE 100	Decision-making in the Agri-Food System	3
AFRE 130	Farm Management I	3

4. One of the following advanced management courses (3 credits):

ANS 422	Advanced Beef Cattle Feedlot Management	3
ANS 434	Dairy Management II	3
ANS 442	Advanced Horse Management	3
ANS 472	Advanced Swine Management	3
ANS 482	Advanced Companion Animal Management	3
FSC 432	Food Processing: Dairy Foods	3
FSC 433	Food Processing: Muscle Foods	3

Courses used to fulfill this requirement may not be used to fulfill requirement 3. f. above.

5. A minimum of 9 credits from the following courses:

ANS 211	Animal and Product Evaluation	3
ANS 305	Applied Animal Behavior	3
ANS 305L	Applied Animal Behavior Laboratory	1
ANS 307	Animal Reproduction	3
ANS 309	Animal Health and Disease Management	3
ANS 313	Principles of Animal Feeding and Nutrition (W)	4
ANS 314	Genetic Improvement of Domestic Animals (W)	4
ANS 315	Anatomy and Physiology of Farm Animals	4
ANS 404	Introduction to Quantitative Genetics	3
ANS 407	Food and Animal Toxicology	3

ANS 409 Problems, Controversies and Advancements in Reproduction (W) 4
ANS 413 Non-Ruminant Nutrition 4
ANS 418 Animal Agriculture and the Environment 3
ANS 425 Animal Biotechnology 3
ANS 427 Environmental Toxicology and Society 3
ANS 435 Mammary Physiology 4
ANS 445 Equine Exercise Physiology 4
ANS 455 Avian Physiology 4
ANS 483 Ruminant Nutrition 3
Courses used to fulfill this requirement may not be used to fulfill requirement 3. e. above.

Animal Biology and Preveterinary (32 to 39 credits):
1. All of the following courses (11 credits):
BS 162 Organismal and Population Biology 3
BS 172 Organismal and Population Biology Laboratory 2
CEM 161 Chemistry Laboratory I 1
CEM 252 Organic Chemistry II 3
CEM 255 Organic Chemistry Laboratory 2
2. One of the following courses (4 credits):
BMB 200 Introduction to Biochemistry 4
BMB 401 Comprehensive Biochemistry 4
3. A minimum of 9 credits from the following courses:
ANS 404 Introduction to Quantitative Genetics 2
ANS 409 Problems, Controversies and Advancements in Reproduction (W) 4
ANS 413 Non-Ruminant Nutrition 4
ANS 418 Animal Agriculture and the Environment 3
ANS 425 Animal Biotechnology 3
ANS 427 Environmental Toxicology and Society 3
ANS 445 Equine Exercise Physiology 4
ANS 455 Avian Physiology 4
ANS 435 Mammary Physiology (W) 4
ANS 483 Ruminant Nutrition 3
4. A minimum of 8 credits from the following courses:
ANS 305 Applied Animal Behavior 3
ANS 305L Applied Animal Behavior Laboratory 1
ANS 307 Animal Reproduction 3
ANS 309 Animal Health and Disease Management 3
ANS 313 Principles of Animal Feeding and Nutrition (W) 4
ANS 314 Genetic Improvement of Domestic Animals (W) 4
ANS 315 Anatomy and Physiology of Farm Animals 4
IBIO 313 Animal Behavior 3
IBIO 341 Fundamental Genetics 4
MMG 301 Introductory Microbiology 3
MMG 302 Introductory Laboratory for General and Allied Health Microbiology 1
MMG 409 Eukaryotic Cell Biology 3
PHM 450 Introduction to Chemical Toxicology 3
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
Courses used to fulfill this requirement may not be used to fulfill requirement 3. e. above.

Companion and Exotic Animal Biology (30 to 33 credits)
1. All of the following courses (17 credits):
ANS 482 Advanced Companion Animal Management 3
BS 162 Organismal and Population Biology 4
BS 172 Organismal and Population Biology Laboratory 2
CEM 252 Organic Chemistry II 3
CEM 255 Organic Chemistry Laboratory 2
IBIO 328 Comparative Anatomy and Biology of Vertebrates 4
2. One of the following courses (4 credits):
BMB 200 Introduction to Biochemistry 4
BMB 401 Comprehensive Biochemistry 4
3. A minimum of 9 credits from the following courses:
ANS 305 Applied Animal Behavior 3
ANS 305L Applied Animal Behavior Laboratory 1
ANS 307 Animal Reproduction 3
ANS 309 Animal Health and Disease Management 3
ANS 313 Principles of Animal Feeding and Nutrition (W) 4
ANS 314 Genetic Improvement of Domestic Animals (W) 4
ANS 315 Anatomy and Physiology of Farm Animals 4
ANS 404 Introduction to Quantitative Genetics 3
ANS 407 Food and Animal Toxicology 3
ANS 409 Problems, Controversies and Advancements in Reproduction (W) 4
ANS 413 Non-Ruminant Nutrition 4
ANS 418 Animal Agriculture and the Environment 3
ANS 425 Animal Biotechnology 3
ANS 427 Environmental Toxicology and Society 3
ANS 435 Mammary Physiology (W) 4
ANS 445 Equine Exercise Physiology 4
ANS 455 Avian Physiology 4
ANS 483 Ruminant Nutrition 3
IBIO 313 Animal Behavior 3
IBIO 341 Fundamental Genetics 4
IBIO 355 Ecology 3
IBIO 368 Zoo Animal Biology and Conservation 3
IBIO 369 Introduction to Zoo and Aquarium Science 3
Courses used to fulfill this requirement may not be used to fulfill requirement 3. e. above.

Dairy Industry (38 to 40 credits):
1. All of the following courses (24 credits):
ANS 134 Dairy Production I 3
ANS 234 Dairy Production II 3
ANS 334 Dairy Management I 3
ANS 434 Dairy Management II 3
AFRE130 Farm Management I 3
AFRE203 Data Analysis for the Agri-Food System 3
AFRE430 Farm Management II 3
ACC 230 Survey of Accounting Concepts 3
ANS 234 may not be used to fulfill requirement 3.d. above.
2. Choose a minimum of 8 credits from the following courses:
ANS 200C Dairy Cattle Genetics and Evaluation 2
ANS 233 Dairy Feed Management 3
ANS 235 Dairy Herd Reproduction 2
ANS 235L Dairy Herd Reproduction Laboratory 2
ANS 238 Dairy Cattle Health Management 3
3. Choose a minimum of 6 credits from the following courses:
AFRE232 Commodity Marketing I 3
AFRE315 Labor and Personnel Management in the Agri-Food System 3
AFRE435 Financial Management in the Agri-Food System 3
ANS 409 Problems, Controversies, and Advancement in Reproduction (W) 4
ANS 418 Animal Agriculture and the Environment 3
ANS 435 Mammary Physiology (W) 3
ANS 483 Ruminant Nutrition 3
FSC 432 Food Processing: Dairy Foods 3
FSC 432 may not be used to fulfill requirement 3.f. above.

GRADUATE STUDY

The graduate program in animal science is designed to provide students with opportunities to pursue a program that focuses on the basic biomedical and agricultural sciences or on applied management aspects of animal science.

The Department of Animal Science offers Master of Science and Doctoral of Philosophy degree programs in animal science.

Students who are enrolled in Master of Science degree programs in the Department of Animal Science may elect a Specialization in Environmental Toxicology. For additional information, refer to the statement on the specialization in the *College of Agriculture and Natural Resources* section of this catalog.

ANIMAL SCIENCE

Programs of study are based on the strengths of the department and the goals of individual students. Although individual students' programs vary, all graduate programs in animal science are designed to:

1. Provide a strong foundation in biological science and an in–depth knowledge of a specific biological discipline of importance to animal agriculture.
2. Develop creative potential and foster independent thought.
3. Improve technical skills.
4. Provide the foundation for effective, independent careers in extension, research, teaching, or agribusiness.

The department offers the following areas of specialization within the field of animal science: quantitative genetics, systems science, nutrition, physiology of growth, lactation and reproduction, microbiology, molecular biology, toxicology, and livestock and farm management. Research for theses or dissertations may focus on beef or dairy cattle, sheep, swine, horses, poultry, or fur–bearing and laboratory species. Modern animal, computer, and library facilities support research.

Students who are enrolled in the Master of Science degree program in the Department of Animal Science may elect a Specialization in Environmental Toxicology. For additional information, refer to the *Graduate Specialization in Environmental Toxicology* statement.

In addition to meeting the requirements of the university and of College of Agriculture and Natural Resources, the student must meet the requirements specified below.

Admission

To be admitted to the master's or doctoral degree program in animal science, students must have a bachelor's degree in animal science or in a related biological science. To enroll in advanced courses in animal science and supporting sciences, students should have completed courses that establish principles in animal science and in basic physical and biological sciences pertinent to the area of specialization within the field of animal science that the student chooses. In some cases, students may need to complete collateral courses in addition to the courses that are required for the graduate degree. Applicants will be evaluated for admission based on academic record, research and work experience, professional goals, and letters of reference. All applicants are required to submit scores from the General Test of the Graduate Record Examination.

Requirements for the Master of Science Degree in Animal Science

The student may elect either Plan A (with thesis) or Plan B (without thesis). A minimum of 30 credits is required for the degree under either Plan A or Plan B. The student's major professor and guidance committee must approve the student's program of study, including thesis research for students under Plan A.

Requirements for Both Plan A and Plan B

1. Complete a set of courses related to one of the areas of specialization within the field of animal science, as approved by the major professor and guidance committee.

Additional Requirements for Plan A

1. Complete 6 to 10 credits in ANS 899 Master's Thesis Research.
2. Complete a written thesis and present it publicly at a departmental seminar prior to graduation.
3. Pass a final oral examination in defense of the thesis before the guidance committee that occurs immediately after the public seminar at which the thesis is presented.

Additional Requirements for Plan B

1. Complete no more than 6 credits in ANS 898 Master's Research.
2. Complete a project and present it publicly at a departmental seminar prior to graduation.
3. Pass a final examination or evaluation before the guidance committee that occurs immediately after the public seminar at which the project is presented.

Requirements for the Doctor of Philosophy Degree in Animal Science

In cooperation with the student's major professor, the student plans a program of study that includes courses related to one of the areas of specialization within the field of animal science referenced above, seminars, and teaching experience. The student's major professor and guidance committee must approve the student's program of study, including dissertation research.

DEPARTMENT of BIOSYSTEMS and AGRICULTURAL ENGINEERING

Bradley P. Marks, Chairperson

The mission of the Department of Biosystems and Agricultural Engineering is to improve quality of life by integrating and applying principles of engineering and biology to systems involving food, environment, energy, and health. The Department of Biosystems and Agricultural Engineering is administered jointly by the College of Agriculture and Natural Resources and the College of Engineering. For more information, visit *www.egr.msu.edu/bae*.

UNDERGRADUATE PROGRAMS

The department offers a Minor in Technology Systems Management.

The department also offers a Bachelor of Science degree program with a major in biosystems engineering through the College of Engineering. For information about that program, refer to the statement on the *Department of Biosystems and Agricultural Engineering* in the *College of Engineering* section of this catalog.

MINOR IN TECHNOLOGY SYSTEMS MANAGEMENT

The Minor in Technology Systems Management, which is administered by the Departments of Biosystems and Agricultural Engineering, serves students interested in technology for management decision support who are pursuing careers in agriculture and natural resources. The minor provides an opportunity to gain a working knowledge of technologies necessary to monitor and manage aspects of food, agriculture, and natural resource systems.

The minor is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University. With the approval of the department and college that administers 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.

Students who plan to complete the requirements for the minor should consult an undergraduate advisor in the Department of Biosystems and Agricultural Engineering to have their program of study approved in advance and in writing.

Requirements for the Minor in Technology Systems Management

		CREDITS
Students must complete a minimum of 15 credits from the following:		
1. Four of the following courses (12 credits):		
TSM 130	Energy Efficiency and Conservation in Agricultural Systems	3
TSM 222	Fundamentals of Automation and Controls	3
TSM 226	Renewable Energy Systems Management	3
TSM 251	Information Technology in Agricultural Systems	3
TSM 331	Water Management in Agriculture and Food Systems	3
TSM 343	Principles of Precision Agriculture	3
2. One of the following courses (3 or 4 credits):		
ABM 222	Agribusiness and Food Industry Sales (W)	3
ANS 418	Comprehensive Nutrient Management Planning	3
CSS 424	Sustainable Agriculture and Food Systems: Integration and Synthesis	3
CSUS354	Water Resources Management	3
FSC 325	Food Processing: Unit Operations	3
FW 419	Applications of Geographic Information Systems to Natural Resources Management	4
GEO 221	Introduction to Geographic Information	3
TSM 493	Professional Internship in Technology Systems Management	3

LINKED BACHELOR'S-MASTER'S DEGREE IN BIOSYSTEMS ENGINEERING
Bachelor of Science Degree in Biosystems Engineering
Master of Science Degree in Biosystems Engineering

The department welcomes applications from Michigan State University Biosystems Engineering undergraduate students in their junior and senior year. Admission applications must be made during the prior spring semester for an anticipated spring graduation or the prior fall semester for an anticipated fall graduation to allow admission before the final semester as a Biosystems Engineering undergraduate. Admission to the program requires a minimum undergraduate grade-point average of 3.5 and an approved program of study for the Master of Science degree in Biosystems Engineering at the time of admission. Admission to the Linked Bachelor's-Master's program allows the application of up to 9 credits toward the master's program for qualifying 400-level and above course work taken at the undergraduate level at Michigan State University or another postsecondary accredited institution of comparable academic quality. The number of approved credits, not to exceed 9, are applied toward the credit requirement of the master's degree. Credits applied to the Linked Bachelor's-Master's program are not eligible to be applied to any other graduate degree program.

GRADUATE STUDY

The Department of Biosystems and Agricultural Engineering offers the programs listed below:

Master of Science
biosystems engineering
Doctor of Philosophy
biosystems engineering

Study for the department's master's and doctoral degree programs is administered by the College of Agriculture and Natural Resources.

BIOSYSTEMS ENGINEERING

Biosystems engineers apply the basic sciences, mathematics, engineering sciences, and technology to design sustainable solutions to problems with a critical biological component. Biosystems engineers work to ensure an adequate and safe food supply while efficiently utilizing natural resources and protecting the environment. Specific application areas include food and biomass production systems, food processing systems, processing systems for utilization and conversion of biological products, water and waste management systems, natural resource and environmental protection, and a range of other biological challenges that require engineering expertise.

The department offers both Master of Science and Doctor of Philosophy degree programs with majors in biosystems engineering.

Master of Science

The Master of Science degree program in biosystems engineering is designed to prepare graduates for advanced career opportunities that require disciplinary expertise beyond that available in the Bachelor of Science degree. The program is available under Plan A (thesis) and Plan B (without thesis). Plan A introduces the student to research methods, and the student is expected to execute, analyze, and publish an original research project under the guidance of an advisor. Plan B is suited for those who do not plan a research-related career, but desire additional skills and knowledge obtained through advanced course work.
In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

To be considered for admission to the Master of Science degree program in biosystems engineering, an applicant must take the Graduate Record Examination General Test and have the scores sent to the department.

Regular Status. Admission to the master's degree program in biosystems engineering with regular status may be granted by the department, subject to the availability of resources and to the approval of the dean, upon consideration of the likelihood that the applicant will be able to complete a master's degree program successfully. To be admitted to the master's program in biosystems engineering, an applicant must have:

1. A grade–point average not lower than 3.00 for the final two years of the undergraduate program, or standing in the upper quarter of the graduating class in the student's major.
2. A bachelor's degree, either:
   a. from an accredited program in engineering, or
   b. from a related science-oriented program in which the applicant has shown very high academic achievement, as certified by the department.

An applicant without an engineering degree must demonstrate the abilities and experience necessary to succeed in the core courses, Biosystems Engineering 815, 825, and 835. The student must complete, previously, or within the master's program, a significant engineering design experience.

Provisional Status. Admission to the master's degree program in biosystems engineering with provisional status may be granted by the department, subject to the approval of the dean:

1. To an applicant qualified for regular admission except that collateral courses are deemed necessary, or
2. To an applicant whose record is incomplete.

If collateral courses are required, the minimum acceptable grades and the semesters by which those courses must be completed will be specified on the admission form. Biosystems Engineering 490 and 890 may not be used to satisfy collateral course requirements.

The provisional status will be changed to regular status when the conditions specified on the admission form have been met, as certified by the department and approved by the dean.

Registration as a Professional Engineer

Students who wish to satisfy the requirements of the State Board of Registration for Professional Engineers should consult with the Department of Biosystems and Agricultural Engineering.

Program Filing

The student's program of study must be approved before the student completes 6 credits of graduate work in order for the student to continue to enroll in the master's degree program. The subject matter and instructor must be specified for every independent study, special problems, or selected topics course that is included in the student's approved program of study.

Modification of Program

After the Plan A or Plan B option has been selected by the student and approved, the student may not pursue the other option without approval of the department.

The following changes are not permitted in a student's approved program of study:

1. Adding or deleting a course for which a grade has already been assigned under any of the three grading systems (numerical, Pass–No Grade, or Credit–No Credit).
2. Adding or deleting a course for which grading was postponed by the use of the DF–Deferred marker.
3. Adding or deleting a course which the student dropped after the middle of the semester and for which "W" or "N" or "0.0" was designated.
4. Adding or deleting a course during the final semester of enrollment in the master's degree program.

Requirements for the Master of Science Degree in Biosystems Engineering

The program is available under both Plan A (with thesis) and Plan B (without thesis). The student's program of study must be developed in consultation with the major professor, must be approved by the department, and must meet the requirements specified below:

CREDITS

Requirements for Both Plan A and Plan B:

The student must complete:

1. A total of 30 credits in 400–, 800–, and 900–level courses. At least 20 of the 30 credits must be in 800–900 level courses. Not more than 4 credits of Biosystems Engineering 890 may be counted toward the requirements for the degree under Plan A. Not more than 6 credits of Biosystems Engineering 890 may be counted toward the requirements for the degree under Plan B.
2. All of the following courses:

BE	815	Experimentation and Instrumentation in Biosystems Engineering	3
BE	820	Research Methods in Biosystems Engineering	1
BE	835	Modeling Methods in Biosystems Engineering	3
BE	892	Biosystems Engineering Seminar	1

3. Complete one course in statistics at the 400-level or above from MSU that was not used to meet the requirements of the undergraduate degree. An approved list of courses is maintained in the department.

Additional Requirements for Plan A:

The student must:

1. Complete the following course:

BE	899	Master's Thesis Research	6

   Not more than 8 credits of Biosystems Engineering 899 may be counted toward the requirements for the degree under Plan A.
2. Pass a final oral examination over, and in defense of, the written thesis. The final examination is administered by the department and conducted by the student's guidance committee.
3. Submit at least one paper to a refereed journal before scheduling the oral examination in defense of the thesis. The student must be the primary author, and the manuscript must be based on work completed during the master's program. The guidance committee will recommend a list of appropriate refereed journals. These requirements may be waived under extraordinary circumstances at the request of the advisor or guidance committee and approval by the graduate director and department chairperson.
4. Provide to the major professor and to the department an electronic copy of the thesis approved by ProQuest.

Additional Requirements for Plan B:

The student must:
1. Carry out a project and pass the final examination administered by the student's guidance committee over the course work in the student's approved program of study.
2. Include both a written and an oral component of the examination. The examination structure and expectations will be conveyed by the student's guidance committee or major professor, to the student prior to the examination.
3. Submit a formal report of the Plan B project.

Academic Standards

1. **Grades**. The student must earn a grade of 2.0 or higher in each course in the approved program of study. The student must repeat any course in the approved program for which the grade earned was below 2.0.
2. **Cumulative Grade–Point Average**. The student must maintain a cumulative grade–point average of at least 3.00 in the courses in the approved program of study.
3. **Probational Status**. A student is placed on probational status if the student's cumulative grade–point average for the courses in the approved program of study is below 3.00. A student in probational status is not allowed to carry more than 7 credits per semester or to enroll in any course the primary focus of which is independent study.
4. **Retention In and Dismissal From the Program**.
   a. **Cumulative Grade–Point Average**. Should a student's cumulative grade–point average fall below 3.00 after having completed 16 or more credits in courses in the approved program of study, the student may be enrolled in probational status in the master's degree program for one additional semester. If at the end of the additional semester the student's cumulative grade–point average is 3.00 or higher, the student may continue to enroll in the master's degree program. If at the end of the additional semester the student's cumulative grade–point average is still below 3.00, the student will be dismissed from the program.
   b. **Academic Progress and Professional Potential**. Each student's academic progress and professional potential are evaluated by March 15 of each year. A student who in the judgment of the faculty is making satisfactory academic progress and has professional potential may continue to enroll in the master's degree program. A student who in the judgment of the faculty is not making satisfactory academic progress or lacks professional potential will be dismissed from the program.

Transfer Credits

As a member of the Michigan Coalition for Engineering Education (MCEE), Michigan State University will accept up to one less than half of the course credits required for the Master of Science degree program in Biosystems Engineering in transfer from other MCEE member institutions provided that (1) the student earned a grade of at least 3.0, or the equivalent, in the related courses; (2) the credits were not earned in research or thesis courses; and (3) the related courses are acceptable to the department.

For information about transfer credits from institutions that are not members of the MCEE, refer to the statement on *MASTER'S PROGRAMS*, Transfer Credits, in the *Graduate Education* section of this catalog.

Doctor of Philosophy

The Doctor of Philosophy degree in Biosystems Engineering is designed to prepare graduates for advanced careers that require demonstrated research skills and comprehensive knowledge of the discipline. The program is suitable only for those students who have shown outstanding ability and potential in the field, either by high quality work in a Master of Science degree or by exceptional achievement in a Bachelor of Science degree and additional technical and professional accomplishments. During teaching and training experiences, the student is expected to demonstrate in-depth and comprehensive knowledge of the discipline and skills essential to the dissemination of that knowledge. Additionally, the student must be able to plan, conduct, manage, and publish independent, original research via the dissertation and peer-reviewed manuscripts.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

To be considered for admission to the Doctor of Philosophy degree program in biosystems engineering, an applicant must take the Graduate Record Examination General Test and have the scores sent to the department.

Regular Status. Admission to the doctoral degree program in biosystems engineering with regular status may be granted by the department, subject to the availability of resources and to the approval of the dean.

To be admitted to the doctoral program in biosystems engineering, an applicant should have a master's degree and must:
1. Have either a Bachelor of Science degree in engineering or a master's degree in engineering.
2. Demonstrate evidence of ability and resolution to complete a doctoral program, as attested by the department upon review of the applicant's academic record, test scores, experience, reference statements, professional qualifications, proposed studies, and other relevant information.

Admission to the doctoral program without a master's degree, or the equivalent thereof, requires special approval by the department and the dean.

Provisional Status. Admission to the doctoral degree program in biosystems engineering with provisional status may be granted by the department, subject to the approval of the dean:
1. To an applicant qualified for regular admission except that collateral courses are deemed necessary, or
2. To an applicant whose record is incomplete.

A student who is admitted to the Doctor of Philosophy degree program without a Master of Science degree in engineering may be required to complete collateral courses,

in addition to the courses that are required for the doctoral degree. If collateral courses are required, they will be specified on the admission form. Biosystems Engineering 490 and 890 may not be used to satisfy collateral course requirements.

The provisional status will be changed to regular status when the conditions specified on the admission form have been met, as determined by the department and approved by the dean.

Guidance Committee

The student's guidance committee consists of at least four regular faculty members and is appointed by the department chairperson in consultation with the student and the appropriate faculty members, and with the approval of the dean. At least two members of the guidance committee shall be from the Department of Biosystems and Agricultural Engineering and at least one member shall be from a different department preferably in the College of Agriculture and Natural Resources or the College of Engineering. The chairperson of the guidance committee will be appointed by the department chairperson after consultation with the student and the person recommended to chair the committee.

Guidance Committee Report

The student's program of study shall be submitted for approval to the Department of Biosystems and Agricultural Engineering and to the dean by no later than the end of the student's second semester of enrollment in the doctoral program. The subject matter and instructor must be specified for every independent study, special problems, or selected topics course that is included in the student's approved program of study.

The student's program of study must be approved in order for the student to continue to enroll in the doctoral degree program beyond the second semester.

Modification of Program

The following changes are not permitted in a student's approved program of study:

1. Adding or deleting a course for which a grade has already been assigned under any of the three grading systems (numerical, Pass–No Grade, or Credit–No Credit).
2. Adding or deleting a course for which grading was postponed by the use of the DF–Deferred marker.
3. Adding or deleting a course which the student dropped after the middle of the semester and for which “W” or “N” or “0.0" was designated.
4. Adding or deleting a course during the final semester of enrollment in the doctoral degree program.

Requirements for the Doctor of Philosophy Degree in Biosystems Engineering

The student must:

			CREDITS
1. Complete a minimum of 38 additional course credits (excluding BE 899 or BE 999) beyond the bachelor’s degree, at the 400-level or higher, approved by the student’s guidance committee. The specific courses that a student is required to complete will depend on prior academic background in relation to the selected area of study and research, and must include the following:			
	BE	815 Experimentation and Instrumentation in Biosystems Engineering	3
	BE	820 Research Methods in Biosystems Engineering	1
	BE	835 Modeling Methods in Biosystems Engineering	3
	BE	892 Biosystems Engineering Seminar	1

2. Complete one course in a biological science at Michigan State University at the 400-level or above. The courses applied to the bachelor’s program cannot be used to satisfy this requirement. An approved list of courses will be maintained by the department.
3. Complete one course in quantitative analysis or mathematics at Michigan State University at the 400-level or above. The courses applied to the bachelor’s program cannot be used to satisfy this requirement. An approved list of courses will be maintained by the department.
4. Complete one course in statistics at Michigan State University at the 800-level or above. The courses applied to the bachelor’s program cannot be used to satisfy this requirement. An approved list of courses will be maintained by the department.
5. Complete a minimum of 24 credits of BE 999 Doctoral Dissertation Research. Students may not exceed 36 credits of BE 999.
6. Pass the doctoral qualifying examination.
7. Pass the doctoral comprehensive examination within five years of the date of first course enrollment that counts to the student’s program of study and at least six months prior to the final oral examination in defense of the dissertation. The examination may be retaken once.
8. Submit at least two papers to refereed journals before scheduling the oral examination in defense of the dissertation. The student must be the primary author, and the manuscripts must be based on work completed during the Ph.D. program. The guidance committee will recommend a list of appropriate refereed journals. These requirements can be waived under extraordinary circumstances at the request of the advisor or guidance committee and approval by the graduate director and department chairperson.
9. Pass the final oral examination in defense of the dissertation. The examination may be retaken once.
10. Provide to the major professor, and to the department, an electronic copy of the dissertation approved by ProQuest.

Academic Standards

1. **Grades**. The student must earn a grade of 2.0 or higher in each course in the approved guidance committee report, including collateral courses and courses accepted in transfer. The student must repeat any course on the approved program for which the grade earned was below 2.0.
2. **Cumulative Grade–Point Average**. The student must maintain a cumulative grade–point average of at least 3.00 in courses in the approved guidance committee report, with the exception of collateral courses and courses accepted in transfer.
3. **Deferred Grades**. A student may accumulate no more than three deferred grades (identified by the DF–Deferred marker) in courses other than independent study.
4. **Probational Status**. A student is placed on probational status if either or both of the following conditions apply:
   a. The student's cumulative grade–point average for the courses in the approved guidance committee report is below 3.00.
   b. The student has accumulated more than three deferred grades (identified by the DF–Deferred

marker) in courses other than those courses the primary focus of which is independent study.

A student in probational status is not allowed to carry more than 7 credits per semester or to enroll in any course the primary focus of which is independent study.

5. **Retention In and Dismissal From the Program**.
   a. **Cumulative Grade–point Average**. Should a student's cumulative grade–point average fall below 3.00 after having completed half of the courses in the approved guidance committee report, the student may be enrolled in probational status in the doctoral degree program for one additional semester. If at the end of the additional semester the student's cumulative grade–point average is 3.00 or higher, the student may continue to enroll in the doctoral degree program. If at the end of the additional semester the student's cumulative grade–point average is still below 3.00, the student will be dismissed from the program.
   b. **Deferred Grades**. Should a student accumulate more than three deferred grades (identified by the DF–Deferred marker) in courses other than independent study, the student may be enrolled on probational status in the doctoral degree program for one additional semester. If at the end of the additional semester the student has no more than three deferred grades, the student may continue to enroll in the doctoral degree program. If at the end of the additional semester the student still has more than three deferred grades, the student will be dismissed from the program.
   c. **Academic Progress and Professional Potential**. Each student's academic progress and professional potential are evaluated spring semester of each year. A student who in the judgment of the faculty is making satisfactory academic progress and has professional potential may continue to enroll in the doctoral degree program. A student who in the judgment of the faculty is not making satisfactory academic progress or lacks professional potential will be dismissed from the program.

DEPARTMENT of COMMUNITY SUSTAINABILITY

Rebecca Carina Jordan, Chairperson

The Department of Community Sustainability is an interdisciplinary department that offers programs leading to the Bachelor of Science, Master of Arts, Master of Science, and Doctor of Philosophy degrees.

The department's faculty reflects a unique integration of the social sciences, humanities and natural sciences across its research, teaching and outreach missions. This integration advances the department's goal of educating scholars and practitioners who are able to create, integrate and harness new knowledge to protect and improve both social and natural systems. Students can focus their interests in community sustainability around majors and courses that address natural resources and the environment, food systems, recreation and tourism, education and leadership.

The department's programs reflect an understanding that how students learn is as important as what they learn. Courses, service-learning projects, internships, study abroad programs and other co-curricular activities combine academic content with the building of competencies such as fostering dialogue and action on critical issues, decision-making, leveraging diversity in communities and organizations, encouraging innovation within organizations and/or communities, and promoting and sustaining positive change.

UNDERGRADUATE PROGRAMS

AGRICULTURE, FOOD AND NATURAL RESOURCES EDUCATION

The Bachelor of Science Degree in Agriculture, Food and Natural Resources Education is designed to prepare students for careers as school-based agriculture, food and natural resources teachers at the secondary-level, careers in agricultural and natural resource education fields, or for professional or graduate studies.

Requirements for the Bachelor of Science Degree in Agriculture, Food and Natural Resources Education

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 Agriculture, Food and Natural Resources Education.

   The University's Tier II writing requirement for the Agriculture, Food and Natural Resources major is met by completing Community Sustainability 301. That course is referenced in item 3. below.

   Students who are enrolled in the Agriculture, Food, and Natural Resources Education major leading to the Bachelor of Science degree in the Department of Community Sustainability may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 162 and 172, and Chemistry 141. The completion of Biological Science 172 satisfies the laboratory requirement. Biological Science 162 and 172, and Chemistry 141 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirements may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree. Certain courses referenced in item 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:

   a. All of the following courses (61 credits):

			CREDITS
ANS	110	Introductory Animal Agriculture	3
BS	161	Cell and Molecular Biology	3
BS	162	Organismal and Population Biology	3
BS	172	Organismal and Population Biology Laboratory	2
CSS	101	Introduction to Crop Science	3
CSS	210	Fundamentals of Soil Science	3
CEM	141	General Chemistry	4
CEP	240	Diverse Learners in Multicultural Perspective	3
CSUS	200	Introduction to Sustainability	3
CSUS	222A	Seminar in Instructional Theory I – Agriculture, Food and Natural Resources Education	1

CSUS 222B Seminar in Instructional Theory II – Agriculture, Food and Natural Resources Education 1
CSUS 222C Seminar in Instructional Theory III – Agriculture, Food and Natural Resources Education 1
CSUS 300 Theoretical Foundations of Sustainability 3
CSUS 301 Community Engagement for Sustainability (W) 3
CSUS 316 Campus Apprenticeship in Agriculture, Food, and Natural Resources Education 3
CSUS 317 Foundations of Teaching Agriculture, Food, and Natural Resources 3
CSUS 343 Community Food and Agriculture Systems 3
CSUS 493 Professional Internship in Community Sustainability 6
FOR 202 Introduction to Forestry 3
HRT 203 Introduction to Horticulture 3
IBIO 355 Ecology 3
IBIO 355L Ecology Laboratory (W) 1

b. One of the following courses (3 credits):
AFRE 100 Decision-making in the Agri-Food System 3
AFRE 130 Farm Management I 3

c. One of the following courses (3 credits):
CSUS 464 Environmental and Natural Resource Policy in Michigan 3
CSUS 465 Environmental and Natural Resource Law 3

d. All of the following courses for students admitted into the secondary teacher education program (12 credits):
CSUS 417 Agriculture, Food, and Natural Resources Apprenticeship/Clinical Experience 3
CSUS 817 Instructional Design and Assessment in Agriculture, Food, and Natural Resources Education 3
CSUS 818 Theory and Practice of Program Planning in Agriculture, Food, and Natural Resources Education 3
CSUS 819 Instructional Theory and Practice in Agriculture, Food, and Natural Resources Education 3

e. All of the following courses for students not pursuing secondary teacher education certification (12 credits):
CSUS 430 Non-Profit Organizational Management for Community Sustainability 3
CSUS 433 Grant Writing and Fund Development 3
An additional 6 credits of electives approved by the student's academic advisor.

ENVIRONMENTAL STUDIES AND SUSTAINABILITY

The Department of Community Sustainability offers a Bachelor of Science degree program with a major in Environmental Studies and Sustainability. This program of study is concerned with who uses natural resources, how they use them, and how positive outcomes of use can be enhanced and negative impacts can be mitigated. It examines resource use and allocation through the lenses of community engagement, sustainability and environmental justice. Students benefit from a broad range of interdisciplinary courses, as well as disciplinary and methods courses carefully selected to enhance students' technical knowledge. Professional internship, and education abroad experiences are encouraged to provide students with experiences beyond the classroom and the university campus. Graduates of this program will be prepared to enter professions in environmental, natural resource, agricultural and community development fields through careers in education, government, private industry, non-profit organizations, and public relations and communications or enter a professional or graduate school program.

Requirements for the Bachelor of Science Degree in Environmental Studies and Sustainability

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 Environmental Studies and Sustainability.

   The University's Tier II writing requirement for the Environmental Studies and Sustainability major is met by completing Community Sustainability 301. That course is referenced in item 3. d. below.

   Students who are enrolled in the Environmental Studies and Sustainability major leading to the Bachelor of Science degree in the Department of Community Sustainability may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 162 and 172, and Chemistry 141. The completion of Biological Science 172 satisfies the laboratory requirement. Biological Science 162 and 172, and Chemistry 141 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements for the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major (64 to 66 credits):

CREDITS

a. All of the following Science Foundations courses (15 credits):
BS 161 Cell and Molecular Biology 3
BS 162 Organismal and Population Biology 3
BS 172 Organismal and Population Biology Laboratory 2
CEM 141 General Chemistry 4
IBIO 355 Ecology 3

b. One of the following Applied Earth Sciences courses (3 or 4 credits):
CSS 210 Fundamentals of Soil Science 3
GEO 206 Physical Geography 3
GLG 201 The Dynamic Earth 4

c. All of the following Community Sustainability Core courses (16 credits):
CSUS 200 Introduction to Sustainability 3
CSUS 221 Seminar in Environmental and Sustainability Careers 1
CSUS 300 Theoretical Foundations of Sustainability 3
CSUS 301 Community Engagement for Sustainability (W) 3
CSUS 310 History of Environmental Thought and Sustainability 3
CSUS 400 Topics in Environmental Justice 3

d. One of the following Intermediate Energy, Water, Land courses (3 credits):
CSUS 259 Sustainable Energy and Society 3
CSUS 320 Environmental Planning and Management 3
CSUS 354 Water Resources Management 3

e. One of the following Advanced Energy, Water, Land courses (3 credits):
CSUS 426 Conservation Planning and Adaptive Management 3
CSUS 453 Watershed Planning and Management 3
CSUS 459 Clean Energy System Policy 3

f. Two of the following Community Sustainability Intermediate Electives (6 credits):
CSUS 215 International Development and Sustainability 3
CSUS 265 Exploring Environmental and Sustainability Issues and Policy Using Film 3
CSUS 273 Introduction to Travel and Tourism 3
CSUS 276 Sustaining our National Parks and Recreation Lands 3
GEO 221 Introduction to Geographic Information 3

g. Two of the following Community Sustainability Advanced Electives (6 or 7 credits):
CSUS 343 Community Food and Agricultural Systems 3
CSUS 431 Interpretation and Visitor Information Systems 3
CSUS 445 Community-Based Environmental and Sustainability Education 3
CSUS 473 Social Entrepreneurship for Community Sustainability 3
CSUS 476 Natural Resource Recreation Management 4

h. Two of the following Administration and Leadership courses (6 credits):
CSUS 322 Leadership for Community Sustainability 3
CSUS 429 Program Evaluation for Community Sustainability 3
CSUS 430 Non-Profit Organizational Management for Community Sustainability 3
CSUS 433 Grant Writing and Fund Development 3

i. One of the following Policy and Law courses: (3 credits)
CSUS 464 Environmental and Natural Resource Policy in Michigan 3
CSUS 465 Environmental and Natural Resource Law 3
j. A minimum of 3 credits in one of the following courses:
CSUS 418 Community Sustainability Study Abroad 3 to 6
CSUS 419 International Studies in Community Sustainability 3 to 12
CSUS 493 Professional Internship in Community Sustainability 3 to 6
Students may substitute another appropriate course with approval of the department.

SUSTAINABLE PARKS, RECREATION and TOURISM

The Department of Community Sustainability offers a Bachelor of Science degree in Sustainable Parks, Recreation and Tourism. By combining a body of specialized professional knowledge with the study of natural, social, management and behavioral sciences, the program provides an opportunity for students to obtain a broad, interdisciplinary education which emphasizes a professional area of knowledge integrated with the tenets of sustainability. The major is designed to prepare students for professional positions related to the management and enjoyment of the outdoors. Such positions include management of public parks, forests and protected areas, non-profit lands and facilities such as camps, and commercial enterprises that provide goods and services to outdoor enthusiasts. Meeting people's outdoor leisure needs, enhancing the quality of life, and providing sustainable economic and social development are hallmarks of the major.

Students in the Sustainable Parks, Recreation and Tourism major will acquire an understanding of natural resource recreation and tourism that integrates sustainability and effectively links theory with practice while engaging the community. This includes the concepts of leisure, tourism, recreation and sustainability, as well as operation of recreation delivery systems, policy, administration, management, planning and evaluation.

Government, non-profit and for-profit entities offer a variety of career opportunities in the parks, recreation and tourism field. These opportunities include careers in park and land management, recreation and conservation law enforcement, nature and cultural interpretation, non-profit camp and adventure organization management, commercial recreation enterprise management of cruise ships, resorts, marinas, adventure travel firms, outfitting and guiding services and in coordinating and promoting tourism systems at from the local, state and federal levels through convention and visitor bureaus, chambers of commerce, economic development organizations and industry associations. Graduates are also well prepared for graduate studies relating to the park, recreation and tourism field, as well as a broad range of social and natural science disciplines.

Requirements for the Bachelor of Science Degree in Sustainable Parks, Recreation and Tourism

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 Sustainable Parks, Recreation and Tourism.
   The University's Tier II writing requirement for the Sustainable Parks, Recreation and Tourism major is met by completing Community Sustainability 301. That course is referenced in item 3. below.
   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.
   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:

			CREDITS
a. All of the following courses (12 to 15 credits):			
CSUS	200	Introduction to Sustainability	3
CSUS	300	Theoretical Foundations of Sustainability	3
CSUS	301	Community Engagement for Sustainability (W)	3
CSUS	493	Professional Internship in Community Sustainability	3 to 6
b. Six of the following courses (18 or 19 credits):			
CSUS	273	Introduction to Travel and Tourism	3
CSUS	276	Sustaining Our National Parks and Recreation Lands	3
CSUS	430	Non-Profit Organizational Management for Community Sustainability	3
CSUS	433	Grant Writing and Fund Development	3
CSUS	473	Social Entrepreneurship for Community Sustainability	3
CSUS	474	Advanced Topics in Tourism Management	3
CSUS	476	Natural Resource Recreation Management	4
c. One of the following courses (3 or 4 credits):			
FOR	419	Applications of Geographic Information Systems to Natural Resources Management	4
GEO	221	Introduction to Geographic Information	3
d. Five of the following courses (14 or 15 credits):			
ACC	230	Survey of Accounting Concepts	3
CSS	210	Fundamentals of Soil Science	3
CSUS	310	History of Environmental Thought and Sustainability	3
CSUS	354	Water Resources Management	3
CSUS	429	Program for Community Sustainability Evaluation	3
CSUS	431	Interpretation and Visitor Information Systems	3
CSUS	445	Community-Based Environmental and Sustainability Education	3
CSUS	464	Environmental and Natural Resource Policy in Michigan	3
CSUS	465	Environmental and Natural Resource Law	3
EEM	255	Ecological Economics	3
FI	320	Introduction to Finance	3
FOR	215	Introduction to Wildland Fire	2
GBL	323	Introduction to Business Law	3
HB	100	Introduction to Hospitality Business	2
HB	237	Hospitality Lodging Systems	3
HB	267	Management of Food and Beverage Systems	3
MGT	325	Management Skills and Processes	3
MKT	327	Introduction to Marketing	3

MINOR IN SUSTAINABLE NATURAL RESOURCE RECREATION MANAGEMENT

The Minor in Sustainable Natural Resource Recreation Management is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University. Focusing on the management of people, facilities, natural resources and organizations that provide natural resource recreation opportunities, it targets students considering careers in public land management, commercial recreation enterprises, non-profit resource-based camps and educational facilities, rural community development, forestry, fisheries, wildlife, criminal justice (conservation/recreation law enforcement), landscape architecture, environmental policy or agriculture. The minor offers students the opportunity to integrate knowledge of social, biological and physical sciences, natural resources and ecosystems to sustainably manage for outcomes that include outdoor recreation.

With the approval of the department that administers the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Sustainable Natural Resource Recreation Management

				CREDITS
1.	Both of the following courses (7 credits):			
	CSUS	276	Sustaining Our National Parks and Recreation Lands	3
	CSUS	476	Natural Resource Recreation Management	4
2.	One of the following courses outside the student's course requirements for the major (3 or 4 credits):			
	ANS	110	Introductory Animal Agriculture	4
	CSS	101	Introduction to Crop Science	3
	CSUS	200	Introduction to Sustainability	3
	CSUS	273	Introduction to Travel and Tourism	3
	FOR	202	Introduction to Forestry	3
	FW	101	Fundamentals of Fisheries and Wildlife Ecology and Management	3
3.	Two of the following courses, one of which is outside the student's course requirements for the major (5 to 7 credits):			
	CSS	210	Fundamentals of Soil Science	3
	CSUS	278	Introduction to Conservation, Recreation and Environmental Enforcement	1
	CSUS	354	Water Resources Management	3
	CSUS	431	Interpretation and Visitor Information Systems	3
	CSUS	464	Environmental and Natural Resource Policy in Michigan	3
	CSUS	465	Environmental and Natural Resource Law	3
	CSUS	473	Social Entrepreneurship and Community Sustainability	3
	CSUS	474	Advanced Topics in Tourism Management	3
	FOR	404	Forest Ecology	3
	FOR	412	Wildland Fire	2
	FOR	466	Natural Resource Policy	3
	FW	419	Applications of Geographic Information Systems to Natural Resources Management	4
	GEO	221	Introduction to Geographic Information	3
	IBIO	355	Ecology	3

TEACHER CERTIFICATION OPTIONS

The agriculture, food and natural resources education (AFRNE) disciplinary major leading to the Bachelor of Science degree is available for teacher certification. Students who complete the requirements for the agriculture, food and natural resources education major, the requirements for teacher certification, and a minimum of 4000 hours of recent and relevant work experience are recommended for a career and technical endorsement in agricultural education.

An agriculture, food and natural resources education (AFRNE) disciplinary minor is available for teacher certification.

Students who elect the agriculture, food and natural resources education disciplinary major or the agriculture, food and natural resources education (AFRNE) disciplinary minor, must contact the Department of Community Sustainability.

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

LINKED BACHELOR'S-MASTER'S DEGREE IN AGRICULTURE, FOOD AND NATURAL RESOURCES EDUCATION

Bachelor of Science Degree in Agriculture, Food and Natural Resources Education
Master of Arts Degree in Agriculture, Food and Natural Resources Education

The department welcomes applications from Michigan State University Agriculture, Food and Natural Resources Education undergraduate students in their junior and senior year. Admission applications must be made at least one and a half semesters prior to graduation to allow admission before the final semester as an Agriculture, Food and Natural Resources Education undergraduate. Admission to the program requires a minimum undergraduate grade-point average of 3.5 and an approved program of study for the Master of Arts degree in Agriculture, Food and Natural Resources Education at the time of admission. Admission to the Linked Bachelor's-Master's program allows the application of up to 9 credits toward the master's program for qualifying 400-level and above course work taken at the undergraduate level at Michigan State University or an external accredited institution. The number of approved credits, not to exceed 9, including at least one CSUS course at the 800-level, are applied toward the credit requirement of the master's degree. Credits applied to the Linked Bachelor's-Master's program are not eligible to be applied to any other graduate degree program.

GRADUATE STUDY

The Department of Community Sustainability offers Master of Science and Doctor of Philosophy degree programs in Community Sustainability (CSUS) and Sustainable Tourism and Protected Area Management (STPAM). A Master of Arts degree in Agriculture, Food and Natural Resources Education (AFRNE) is also available.

Graduate programs in the Department of Community Sustainability provide students the opportunity to create individualized programs that draw from several complementary areas of scholarship. These areas include: community food and agricultural systems; natural resources and the environment; tourism and recreation systems; education and civic engagement; and international development. Today's communities face complex problems due to ongoing changes to our environmental, social and agricultural/food systems. To aid in meeting these challenges, students' programs are designed to provide a thorough grounding in integrative, applied research based on multiple paradigms, disciplines and methods.

Master's and doctoral students in the department may choose either the CSUS or STPAM degree. Master of Science students in the CSUS or STPAM degrees select either the Plan A (research-based) or Plan B (project-based) degree. A student may not earn a master's degree in both programs. Students in the graduate degree programs are eligible for a number of graduate certificates or specializations. See those lists at *https://reg.msu.edu/AcademicPrograms/Default.aspx*.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of Community Sustainability may elect specializations in resource economics. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Resource Economics*.

Students who are enrolled in Master of Science degree programs in the Department of Community Sustainability may elect a Specialization in Environmental Toxicology. For additional information, refer to the *Graduate Specialization in Environmental Toxicology* statement.

AGRICULTURE, FOOD AND NATURAL RESOURCES EDUCATION

Master of Arts

The Master of Arts in Agriculture, Food and Natural Resources Education is designed for persons who seek to acquire advanced professional knowledge related to agriculture, food and natural resources in educational settings. This master's program consists of practice-centered inquiry in professional, interdisciplinary, and foundational studies of agriculture, food and natural resources, and inquiry in educational settings. The program is designed for certified teachers and other educators who wish to continue their professional studies in agriculture, food and natural resources education.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Applications for admission to the master's program are reviewed by faculty who look for evidence of appropriate preparation for advanced interdisciplinary and professional study at the master's level and the likelihood of academic success, as indicated by an applicant's prior educational record, work experience, statement of professional goals, and letters of recommendation. Collateral courses may be required to overcome deficiencies in addition to the requirements for the master's degree. Collateral course work will not count toward the master's degree.

Requirements for the Master of Arts Degree in Agriculture, Food and Natural Resources Education

A minimum of 30 credits is required for the degree under Plan B (without thesis). The student's program of study must be developed in cooperation with and approved by the student's guidance committee and must include the requirements specified below.

				CREDITS
1.	All of the following core courses (12 credits):			
	CSUS	860	Youth Leadership: Theory and Practice	3
	CSUS	861	Educational Theory and Application of Experiential Learning in AFNR	3
	CSUS	863	Agriculture, Food and Natural Resources Education Laboratory Instruction: Theory and Practice	3
	CSUS	898	Master's Professional Project	3
2.	Complete 18 credits from the following:			
	CSUS	430	Non-Profit Organizational Management for Community Sustainability	3
	CSUS	433	Grant Writing and Fund Development (W)	3
	CSUS	445	Community-Based Environmental and Sustainability Education	3
	CSUS	817	Instructional Design and Assessment in Agriculture, Food, and Natural Resources Education	3
	CSUS	818	Theory and Practice of Program Planning in Agriculture, Food, and Natural Resources Education	3
	CSUS	819	Instructional Theory and Practice in Agriculture, Food, and Natural Resources Education	3
	CSUS	833	Program Evaluation in Agriculture and Natural Resources	3
	CSUS	864	Agriculture, Food and Natural Resources Educator Induction	3
	TE	807	Professional Development and Inquiry	3
	TE	818	Curriculum in its Social Context	3
	TE	823	Learning Communities and Equity	3
	TE	825	Diverse Learners and Learning Subjects Matter	3
	TE	831	Teaching School Subject Matter with Technology	3
	TE	843	Secondary Reading Assessment and Instruction	3
	TE	861A	Teaching Science for Understanding	3
3.	Completion and defense of a paper based on the master's professional project.			

COMMUNITY SUSTAINABILITY

Master of Science

The Master of Science in Community Sustainability provides students with opportunities to engage in integrated and applied research and acquire professional skills.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below. Students may not be admitted to both the Master of Science degree in Community Sustainability and the Master of Science degree in Sustainable Tourism and Protected Area Management.

Admission

Applicants must have completed a bachelor's degree or comparable degree requirements from an educational institution. Relevant experience and strong academic backgrounds in the natural, physical, or social sciences are encouraged for applicants to the Master of Science in Community Sustainability. All applicants for admission are required to submit scores from the General Test of the Graduate Record Examination. Collateral courses may be required to overcome deficiencies in addition to the

requirements for the master's degree. Collateral course work will not count towards the master's degree.

Requirements for the Master of Science Degree in Community Sustainability

The student may elect either Plan A (with thesis) or Plan B (without thesis). Plan A emphasizes integrated and applied research and is designed as the foundation for doctoral study. Plan B focuses on the acquisition of well-defined professional skills, appropriate for a terminal degree and for professional employment.

A minimum of 30 credits is required for the degree under Plan A and Plan B. The student's program of study must be developed in cooperation with and approved by the student's guidance committee and must include the requirements specified below.

Requirements for Plan A and Plan B

1. All of the following courses (9 credits):

			CREDITS
CSUS	800	Foundations of Community Sustainability I	3
CSUS	801	Foundations of Community Sustainability II	3
CSUS	802	Introduction to Interdisciplinary Inquiry	3

2. A minimum of 12 credits in course work in a focus area selected in consultation with the student's guidance committee. At least 6 credits of this focus area must be in Community Sustainability courses.

Additional Requirements for Plan A

1. A minimum of 3 credits of quantitative or qualitative methods to be selected in consultation with the student's guidance committee.
2. A minimum of 6 credits of Community Sustainability 899.
3. Completion and public defense of the master's proposal and thesis.

Additional Requirements for Plan B

1. A minimum of 3 credits of a techniques or skill-building course relevant to the student's academic and career goals, to be selected in consultation with the student's guidance committee.
2. An additional 3 credits in the identified focus area.
3. A minimum of 3 credits in CSUS 898 Master's Professional Project that focuses on developing an independent professional or project experience appropriate to the student's academic and career goals.
4. Successful completion and public defense of the master's professional project proposal and final paper based on the professional development project and its contribution to the student's professional goals.

Doctor of Philosophy

The Doctor of Philosophy in Community Sustainability is designed to enable students to generate new knowledge in complementary fields responsive to rapidly changing conditions in our natural environment and agricultural systems.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

To be admitted to the Doctor of Philosophy degree program in Community Sustainability, a student must have completed a master's degree. Relevant experience and strong academic backgrounds in the natural, physical, or social sciences, including independent research experience, are strongly encouraged. All applicants are required to submit scores from the General Test of the Graduate Record Examination. Collateral courses may be required to overcome deficiencies in addition to the requirements for the doctoral degree. Collateral course work will not count towards the doctoral degree.

Requirements for the Doctor of Philosophy Degree in Community Sustainability

A minimum of 60 credits is required for the degree. The student's program of study must be developed in cooperation with and approved by the student's guidance committee and must include the requirements specified below.

1. All of the following courses (9 credits):

			CREDITS
CSUS	800	Foundations of Community Sustainability I	3
CSUS	801	Foundations of Community Sustainability II	3
CSUS	802	Introduction to Interdisciplinary Inquiry	3

   If a student already has credit in any of these courses, these credits must be replaced by another 3 credits of relevant courses chosen in consultation with their advisor.
2. Complete a minimum of 9 credits of course work in advanced research methods, to be selected in consultation with the student's guidance committee, including at least 3 credits in each of quantitative and qualitative methods, with the remaining credits in statistics, quantitative, qualitative, or other advanced research methods.
3. Complete a minimum of 18 credits in course work grouped in two focus areas, each of which must have a minimum of 9 credits. Of these, at least 3 credits in each focus area must be selected from Community Sustainability (CSUS) courses.
4. Prepare a comprehensive examination program statement that presents the student's learning and professional background and goals, and provides a rationale for the student's declared focus areas plus integrating and summarizing the related research literature. This statement is prepared in consultation with the student's guidance committee and is presented to the full faculty for review.
5. Pass a comprehensive examination based on the student's comprehensive examination program statement.
6. Complete 24 credits of doctoral dissertation research, publicly defend the research proposal, and successfully defend the final dissertation, including presenting results of the research in a public seminar during the final oral examination.

   All students are encouraged to prepare at least one paper from the dissertation research suitable for submission to a professional and/or refereed academic journal.

SUSTAINABLE TOURISM AND PROTECTED AREA MANAGEMENT

Master of Science

The Master of Science degree in Sustainable Tourism and Protected Area Management provides students with opportunities to engage in integrated and applied research and to acquire professional skills for the study, management, administration and planning of tourism and protected areas under the overarching concept of community sustainability. In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below. Students may not be admitted to both the Master of Science degree in Community Sustainability and the Master of Science degree in Sustainable Tourism and Protected Area Management.

Admission

Applicants must have completed a bachelor's degree or comparable degree requirements from an educational institution. Relevant experience and strong academic background in the natural, physical, or social sciences are encouraged. Applicants are required to submit scores from the General Test of the Graduate Record Examination.

Collateral courses may be required to overcome deficiencies in addition to the requirements for the master's degree. Collateral course work will not count towards the master's degree.

Requirements for the Master of Science Degree in Sustainable Tourism and Protected Area Management

The student may elect either Plan A (with thesis) or Plan B (without thesis). Plan A emphasizes integrated and applied research and is designed as the foundation for doctoral study. Plan B focuses on the acquisition of well-defined professional skills, appropriate for a terminal degree and for professional employment and development. A minimum of 30 credits is required for the degree under Plan A or Plan B. The student's program of study must be developed in cooperation with and approved by the student's guidance committee and must include the requirements specified below.

Requirements for Plan A and Plan B

			CREDITS
1. All of the following courses (12 credits):			
CSUS	800	Foundations of Community Sustainability I	3
CSUS	801	Foundations of Community Sustainability II	3
CSUS	802	Introduction to Interdisciplinary Inquiry	3
CSUS	814	Sustainable Tourism and Protected Area Management: Theories and Applications	3

2. A minimum of 9 credits in course work in a focus area selected in consultation with the student's guidance committee. At least 3 credits of this focus area must be in Community Sustainability (CSUS) courses related to the student's professional goals in Sustainable Tourism and Protected Area Management.

Additional Requirements for Plan A

1. A minimum of 3 credits of quantitative or qualitative methods to be selected in consultation with the student's guidance committee.
2. A minimum of 6 credits of Community Sustainability 899.
3. Successful completion and public defense of the master's proposal and thesis.

Additional Requirements for Plan B

1. A minimum of 3 credits of a techniques or skill-building course relevant to the student's academic and career goals, to be selected in consultation with the student's guidance committee.
2. An additional 3 credits in the identified focus area.
3. A minimum of 3 credits of master's professional project by enrollment in CSUS 898 that focuses on developing an independent professional or project experience appropriate to the student's academic and career goals.
4. Successful completion and public defense of the master's professional project proposal and final paper based on the professional development project and its contribution to the student's professional goals.

Doctor of Philosophy

The Doctor of Philosophy degree in Sustainable Tourism and Protected Area Management is designed to enable students to generate new knowledge in the complementary fields of tourism and protected area management under the overarching concept of community sustainability.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

To be admitted to the Doctor of Philosophy degree program in Sustainable Tourism and Protected Area Management, a student must have completed a master's degree in any field. Relevant experience and strong academic backgrounds in the natural, physical, or social sciences, including independent research experience, are strongly encouraged.

All applicants are required to submit scores from the General Test of the Graduate Record Examination.

Requirements for the Doctor of Philosophy Degree in Sustainable Tourism and Protected Area Management

The student's program of study must be developed in cooperation with and approved by the student's guidance committee and must include the requirements specified below:

			CREDITS
1. All of the following courses (12 credits):			
CSUS	800	Foundations of Community Sustainability I	3
CSUS	801	Foundations of Community Sustainability II	3
CSUS	802	Introduction to Interdisciplinary Inquiry	3
CSUS	814	Sustainable Tourism and Protected Area Management: Theories and Applications	3

If a student already has credit in any of these courses, these credits must be replaced by another 3 credits of relevant courses chosen in consultation with their advisor.

2. Complete a minimum of 9 credits of course work in advanced research methods, to be selected in consultation with the student's guidance committee, including at least 3 credits respectively in quantitative and qualitative methods with the remaining credits in statistics, quantitative and qualitative, or other advanced research methods courses.
3. Complete a minimum of 15 credits in course work grouped in two focus areas, with a minimum of 9 credits in one and 6 credits in the other. Of these, at least 3 credits in each focus area must be selected from Community Sustainability (CSUS) courses related to the student's professional goals in Sustainable Tourism and Protected Area Management.
4. Prepare a comprehensive examination program statement that presents the student's learning and professional background and goals, and provides a rationale for the student's declared focus areas plus integrating and summarizing the related research literature. This statement is prepared in consultation with the student's guidance committee and is presented to the full faculty for review.
5. Pass a comprehensive examination based on the student's comprehensive examination program statement.
6. Complete 24 credits of doctoral dissertation research, publicly defend the research proposal, and successfully defend the final dissertation, including presenting results of the research in a public seminar during the final oral examination.

   All students are encouraged to prepare at least one paper from the dissertation research suitable for submission to a professional and/or refereed academic journal.

DEPARTMENT of ENTOMOLOGY

Hannah Joy Burrack, Chairperson

Entomology is the field of biological science concerned with the study of insects and their relatives in relation to other animals, plants, microbes, and the environment. Since insects and their relatives' impact many human activities, and must be studied and managed in a variety of environments, an entomologist needs a strong background in the basic sciences.

UNDERGRADUATE PROGRAM

The Department of Entomology offers a Bachelor of Science degree. The program emphasizes developing strengths in the biological, chemical, and physical sciences as necessary to work in modern entomology. Entomology courses provide students with an understanding of the structure,

classification, identification, function, biology, ecology, and management of beneficial and harmful insects, and the communities and ecosystems where they occur. A minor in Entomology is also available.

Requirements for the Bachelor of Science Degree in Entomology

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 Entomology.

   The University's Tier II writing requirement for the Entomology major is met by completing Entomology 479. This course is referenced in item 3. below.

   Students who are enrolled in the Entomology major may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing Entomology's mathematics and chemistry requirements and Biological Science 162. These courses meet the laboratory requirement.
2. The requirements of the College of Agriculture and Natural Resources 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 major requirements:

			CREDITS
a. All of the following courses (47 credits):			
	BS 161	Cell and Molecular Biology	3
	BS 162	Organismal and Population Biology	3
	BS 172	Organismal and Population Biology Laboratory	2
	CEM 141	General Chemistry	4
	CEM 143	Survey of Organic Chemistry	4
	CEM 161	Chemistry Laboratory I	1
	CSS 210	Fundamentals of Soil Science	3
	ENT 404	Fundamentals of Entomology	3
	ENT 479	Organic Pest Management (W)	3
	GEO 221	Introduction to Geographic Information	3
	GEO 221L	Introduction to Geographic Information Laboratory	1
	IBIO 355	Ecology	3
	IBIO 355L	Ecology Laboratory (W)	1
	MTH 124	Survey of Calculus I	3
	PHY 231	Introductory Physics I	3
	PHY 232	Introductory Physics II	3
	PHY 251	Introductory Physics Laboratory I	1
	PLB 218	Plants of Michigan	3
b. One of the following courses (3 credits):			
	MTH 126	Survey of Calculus II	3
	STT 421	Statistics I	3

   Higher equivalent course substitutions may be made for Chemistry, Mathematics, and Physics courses with advisor approval.

   c. A minimum of 16 credits of course work in entomology as approved by the student's academic advisor.

MINOR IN ENTOMOLOGY

The Minor in Entomology, which is administered by the Department of Entomology, is designed to serve students in other fields who desire additional training in the insect sciences. It provides an introduction to a range of entomological knowledge, including insect identification, ecology, and management.

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 Science Degree in Entomology. With the approval of the department and college that administers 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.

Students who plan to complete the requirements for the minor should consult an undergraduate advisor in Entomology.

Requirements for the Minor in Entomology

Complete 15 credits from the following:

			CREDITS
1. The following course (3 credits):			
	ENT 404	Fundamentals of Entomology	3
2. Complete 12 credits from the following:			
	ENT 205	Pests, Society and Environment	3
	ENT 364	Turfgrass Entomology	3
	ENT 407	Diseases and Insects of Forest and Shade Trees	4
	ENT 410	Apiculture and Pollination	2
	ENT 422	Aquatic Entomology	3
	ENT 460	Medical Entomology	3
	ENT 469	Biomonitoring of Streams and Rivers	3
	ENT 470	General Nematology (W)	3
	ENT 477	Pesticides in Pest Management	3
	ENT 478	Integrated Pest Management (W)	3
	ENT 479	Organic Pest Management (W)	3

Other Entomology courses may be used in fulfillment of this requirement with approval from the Entomology undergraduate advisor.

GRADUATE STUDY

The Department of Entomology offers Master of Science and Doctor of Philosophy degree programs. Many of the courses offered by the department are important to other disciplines in the biological and agricultural sciences in the College of Natural Science and College of Agriculture and Natural Resources section of this catalog.

Students enrolled in the Master of Science degree program in the Department of Entomology may elect a specialization in Ecology, Evolution, and Behavior (EEBB). Students enrolled in the Doctor of Philosophy degree program may pursue a dual degree in EEBB. For additional information refer to the statement on *Interdepartmental Degree Programs* in the *College of Natural Science* section of this catalog or contact the Department of Entomology.

ENTOMOLOGY

Faculty and facilities are available for study in many subject areas, including apiculture and pollination, aquatic systems, behavior, insect biochemistry, biological control, bionomics, ecology, insect economics, forest entomology, medical entomology, morphology, nematology, population dynamics, insect physiology, pest management on many kinds of crops, plant disease vectors, systematics, systems science, environmental and analytical toxicology, and urban and ornamental entomology. Combinations of many of these specialized subject areas are necessary for all programs of study. Regardless of specialization, the student's education must provide broad training in related sciences.

Graduate students in entomology look forward chiefly to college teaching; research work in some of the many areas where insects affect our crops and our lives; professional employment with state, federal, or private agencies or companies; or employment as pest management consultants.

Master of Science

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

A bachelor's degree with a 3.00 grade–point average for the last two years of study is required for admission to the master's program. Although the applicant need not have an undergraduate major in entomology for regular admission, training should have been received in the physical and biological sciences equivalent to that required of an undergraduate entomology major at Michigan State University. Students without a general entomology background should complete ENT 404 Fundamentals of Entomology during their first year. Graduate Record Examination General Test scores are required. Applicants with a good academic record but with deficiencies in physics, chemistry, mathematics, or the biological sciences may be accepted on a provisional basis until deficiencies have been rectified by collateral course work.

Requirements for the Master of Science Degree in Entomology

The master's degree program in entomology is available under either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under Plan A or Plan B. The student's program of study must be approved by either the student's guidance committee (Plan A) or the student's major professor (Plan B) and is planned on an individual basis by the student, the student's major professor, and the student's guidance committee.

Requirements for Both Plan A and Plan B

The student must:
1. Complete at least 6 credits in entomology courses at the 400-level or above. More than half of the 30 credits required for the degree must be at the 800-level or above.

Additional Requirements for Plan A
1. Complete at least 6, but not more than 10 credits of Entomology 899.
2. Successfully write and defend the master's thesis research with a departmental seminar.

Additional Requirements for Plan B
1. Complete 3 to 5 credits of a research project in ENT 898 and present a departmental seminar.
2. Pass a final oral examination.

Doctor of Philosophy

The Department of Entomology aspires to develop not only capable entomologists but also capable scholars. Scholarly potential is sought in the prospective student, and course and research programs are designed to round out the student's knowledge and bring it to the stage of development where the student can work creatively in the field.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

A bachelor's degree with a 3.00 grade–point average for the last two years of study is required for admission to the master's program. The applicant need not have an undergraduate major in entomology for regular admission, but should have a background in biology, chemistry, mathematics, physics, and general entomology equivalent to that required of an undergraduate entomology major at Michigan State University. Students without a general entomology background should complete ENT 404 Fundamentals of Entomology during their first year. Graduate Record Examination General Test scores are required. Applicants with a good academic record but with deficiencies may be accepted on a provisional basis until deficiencies have been remediated. Collateral course work does not count towards the requirements for the degree.

Requirements for the Doctor of Philosophy Degree in Entomology

The student's program of study is planned on an individual basis by the students, the student's major professor, and the student's guidance committee. Students must take 9 entomology course credits and complete a minimum of 24 credits of ENT 999 Doctoral Dissertation Research. Within 18 months of matriculation, students must pass a doctoral qualification examination which primarily consists of the defense of a dissertation proposal. Written and oral comprehensive examinations are required after completing course work, covering specific disciplinary areas related to thesis research and broader general knowledge of entomology and related sciences. After completing research, doctoral students are required to write and defend a dissertation with a departmental seminar.

DEPARTMENT of FISHERIES and WILDLIFE

Dana Marie Infante, Chairperson

The Department of Fisheries and Wildlife strongly believes that conservation of natural resources and a healthy environment are vital to the future of humanity. The faculty, staff and students in the Department of Fisheries and Wildlife address global challenges that threaten the sustainability of Earth's ecosystems and their animal populations. Our mission is to build local, national, and international capacities to conserve ecosystems that support fish, wildlife, and society through integrated programs in research, education, and engagement. We strive for increasingly inclusive, positive influences on interdependent human-natural systems and foster a culture built on respect, inclusion, and good governance.

UNDERGRADUATE PROGRAMS

The Fisheries and Wildlife undergraduate majors focus on interactions between humans and the natural world through courses that link three foundational topics: (1) the ecology of Earth's ecosystems and their animal populations, (2) the diversity of ways in which people use and value natural resources, and (3) the application of scientific understanding, using conservation and management techniques to meet global challenges threatening the sustainability of Earth's ecosystems and their animal populations.

The **Bachelor of Science in Applied Conservation Biology** focuses on the science of analyzing and conserving the earth's biological diversity drawing from the biological, physical and social sciences, economics, and the practice of natural resource conservation and management.

The program of study includes course work in the life sciences, social sciences, communication, climate change, environmental policy, and field, lab and analytic techniques; it also includes an experiential learning component, such as study abroad and/or professional internships. Our students value the relatively small class sizes and dedicated faculty instructors. This program prepares students with interests in the life sciences, social sciences, and environmental policy for rewarding careers in conservation biology, as well as fisheries biology, wildlife biology, animal health, and applied ecology. Our graduates most typically find employment with state and federal natural resource agencies, non-profit environmental organizations, private companies, and consulting firms, as well as universities and colleges.

Students who complete the requirements for the Applied Conservation Biology major and choose elective courses appropriately can also satisfy requirements for certification by the American Fisheries Society as an Associate Fisheries Scientist or the Wildlife Society as an Associate Wildlife Biologist.

The **Bachelor of Science in Aquatic Ecology and Management** is designed for students interested in examining the biological, physical, chemical, geological and hydrological aspects of lakes and ponds, rivers and streams, wetlands and groundwaters, with an emphasis on water quality. This major provides students with the understanding and skills needed for careers related to protecting and restoring water resources around the North American Great Lakes region and the world.

The program of study includes course work in the life sciences, social sciences, communication, climate change, environmental policy, and field, lab and analytic techniques; it also includes an experiential learning component, such as study abroad and/or professional internships. Our students value the relatively small class sizes and dedicated faculty instructors.

This program prepares students with interests in the life sciences, social sciences, and environmental policy for rewarding careers in water quality management, fisheries biology, conservation biology, animal and public health, and applied ecology. Our graduates most typically find employment with state and federal natural resource agencies, non-profit environmental organizations, private companies, and consulting firms, as well as universities and colleges.

The **Bachelor of Science in Fish Ecology and Management** is designed for students interested in the research and management of fish populations, other freshwater and marine organisms, and the ecosystems that sustain them.

The program of study includes course work in the life sciences, social sciences, communication, climate change, environmental policy, and field, lab and analytic techniques; it also includes an experiential learning component, such as study abroad and/or professional internships. Our students value the relatively small class sizes and dedicated faculty instructors. This program prepares students with interests in the life sciences, social sciences, and environmental policy for rewarding careers in fisheries biology, water quality management, conservation biology, animal health, and applied ecology. Our graduates most typically find employment with state and federal natural resource agencies, non-profit environmental organizations, private companies and consulting firms, as well as universities and colleges.

Students who complete the requirements for the Fish Ecology and Management major and choose elective courses appropriately can also satisfy requirements for certification by the American Fisheries Society as an Associate Fisheries Scientist.

The **Bachelor of Science in Wildlife Ecology and Management** is for students interested in understanding and managing terrestrial habitats and animals including game, non-game, and endangered species.

The program of study includes course work in the life sciences, social sciences, communication, climate change, environmental policy, and field, lab and analytic techniques; it also includes an experiential learning component, such as study abroad and/or professional internships. Our students value the relatively small class sizes and dedicated faculty instructors. This program prepares students with interests in the life sciences, social sciences, and environmental policy for rewarding careers in wildlife biology, conservation biology, animal health, and applied ecology. Our graduates most typically find employment with state and federal natural resource agencies, non-profit environmental organizations, private companies and consulting firms, as well as universities and colleges.

Students who complete the requirements for the Wildlife Ecology and Management major and choose elective courses appropriately can also satisfy requirements for certification by the Wildlife Society as an Associate Wildlife Biologist.

Requirements for the Bachelor of Science Degree in Fisheries and Wildlife

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 Fisheries and Wildlife.

   The University's Tier II writing requirement for the Fisheries and Wildlife major is met by completing Fisheries and Wildlife 434 referenced in item 3. below.

   Students who are enrolled in the Fisheries and Wildlife major leading to the Bachelor of Science degree in the Department of Fisheries and Wildlife may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing items 3. a. and 3. b. below. The completion of Biological Sciences 171 or 172 or Lyman Briggs 144 and Chemistry 161 or Lyman Briggs 171L satisfies the laboratory requirement. Completion of items 3. a. and 3. b. below will be counted toward both the alternative track and the requirements for the major.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of item 3. d. below satisfies the College's mathematics requirement.
3. The following requirements for the major:

				CREDITS
a. One of the following groups of courses (9 or 10 credits):				
(1)	BS	161	Cell and Molecular Biology	3
	BS	171	Cell and Molecular Biology Laboratory	2
	BS	162	Organismal and Population Biology	3
	BS	172	Organismal and Population Biology Laboratory	2
(2)	LB	144	Biology I – Organismal Biology	4
	LB	145	Biology II: Cellular and Molecular Biology	5
b. One of the following groups of courses (5 credits):				
(1)	CEM	141	General Chemistry	4
	CEM	161	Chemistry Laboratory I	1
(2)	CEM	151	General and Descriptive Chemistry	4
	CEM	161	Chemistry Laboratory I	1
(3)	LB	171	Principles of Chemistry I	4
	LB	171L	Introductory Chemistry Laboratory I	1
c. One course from each group (6 to 8 credits):				
(1)	PHY	231	Introductory Physics I	3
	PHY	183	Physics for Scientists and Engineers I	4
	LB	273	Physics I	4
(2)	CSS	210	Fundamentals of Soil Science	3
	GLG	201	The Dynamic Earth	4
	GEO	203	Introduction to Meteorology	3
	GEO	206	Physical Geography	3
d. One course from each group (6 or 7 credits):				
(1)	MTH	124	Survey of Calculus I	3
	MTH	132	Calculus I	3
	LB	118	Calculus I	4
(2)	STT	231	Statistics for Scientists	3
	STT	224	Introduction to Probability and Statistics for Ecologists	3
	STT	421	Statistics I	3
e. Two of the following courses (6 credits):				
	COM	100	Human Communication	3
	COM	225	Introduction to Interpersonal Communication	3
	COM	275	Effects of Mass Communication	3
	CSUS	433	Grant Writing and Fund Development (W)	3
	FW	435	Integrated Communications for the Fisheries and Wildlife Professional	3
	JRN	472	Environment, Science and Health Reporting	3
	WRA	320	Technical Communication (W)	3
	WRA	331	Writing in the Public Interest (W)	3
	WRA	341	Nature, and Environmental Writing	3
	WRA	453	Grant and Proposal Writing	3
f. One of the following courses (3 credits):				
	FW	439	Conservation Ethics	3
	PHL	340	Ethics	3
	PHL	342	Environmental Ethics	3
	PHL	380	Nature of Science	3
	GEO	432	Environmental Ethics (W)	3
g. Complete at least 3 credits from the following courses):				
	FW	493	Professional Internship in Fisheries and Wildlife	3
	FW	490	Independent Study in Fisheries and Wildlife	3
	FW	480	International Studies in Fisheries and Wildlife	3
	FW	499	Senior Thesis in Fisheries and Wildlife	4
h. All of the following courses (17 credits):				
	FW	101	Fundamentals of Fisheries and Wildlife Ecology and Management	3
	FW	293	Undergraduate Seminar in Fisheries and Wildlife	1
	FW	364	Ecological Problem Solving	3
	FW	424	Population Analysis and Management	4
	FW	434	Human Dimension of Fisheries and Wildlife Management (W)	3
	IBIO	355	Ecology	3
i. One of the following courses (2 or 3 credits):				
	FW	101L	Fundamentals of Fisheries and Wildlife Ecology and Management Laboratory	2
	FW	238	Introductory Fisheries and Wildlife Field Experience	3
j. One of the following concentrations:				
Conservation Biology (27 to 29 credits):				
(1) All of the following courses (12 credits):				
	FW	444	Conservation Biology	3
	FW	445	Biodiversity Conservation Policy and Practice	3
	IBIO	445	Evolution (W)	3
	PLB	443	Restoration Ecology	3
(2) One of the following courses (3 credits):				
	FOR	404	Forest Ecology	3
	IBIO	485	Tropical Biology (W)	3
	PLB	441	Plant Ecology	3
(3) One of the following courses (3 or 4 credits):				
	CSS	350	Introduction to Plant Genetics	3
	IBIO	341	Fundamental Genetics	4
(4) One of the following courses (3 credits):				
	FW	410	Upland Ecosystem Management	3
	FW	414	Aquatic Ecosystem Management	3
	FW	416	Marine Ecosystem Management	3
	FW	417	Wetland Ecology and Management	3
	FW	454	Environmental Hydrology for Watershed Management	3
	FW	479	Fisheries Management	3
(5) One of the following courses (3 credits):				
	CSUS	464	Environmental and Natural Resource Policy in Michigan	3
	CSUS	465	Environmental and Natural Resource Law	3
	EEM	255	Ecological Economics	3
	FW	449	Wildlife Policy	3
	FW	481	Global Issues in Fisheries and Wildlife	3
	FOR	466	Natural Resource Policy	3
	IBIO	446	Environmental Issues and Public Policy	3
	MC	450	International Environmental Law and Policy	3
(6) One of the following courses (3 or 4 credits):				
	ENT	422	Aquatic Entomology	3
	FOR	204	Forest Vegetation	3
	FW	471	Ichthyology	4
	IBIO	360	Biology of Birds	4
	IBIO	365	Biology of Mammals	4
	IBIO	384	Biology of Amphibians and Reptiles (W)	4
	PLB	218	Plants of Michigan	3
	PLB	418	Plant Systematics	3
Fisheries Biology and Management (25 to 28 credits):				
(1) One of the following courses (3 credits):				
	FW	472	Limnology	3
	FW	420	Stream Ecology	3
(2) All of the following courses (10 credits):				
	FW	471	Ichthyology	4
	FW	479	Fisheries Management	3
	FW	474	Field and Laboratory Techniques for Aquatic Studies	3
(3) One of the following courses (3 credits):				
	FW	414	Aquatic Ecosystem Management	3
	FW	416	Marine Ecosystem Management	3
	FW	417	Wetland Ecology and Management	3
	FW	454	Environmental Hydrology for Watershed Management	3
(4) One of the following courses (3 or 4 credits):				
	ENT	404	Fundamentals of Entomology	3
	ENT	422	Aquatic Entomology	3
	IBIO	306	Invertebrate Biology	4
(5) One of the following courses (3 or 4 credits):				
	PLB	418	Plant Systematics	3
	PLB	424	Algal Biology	4
(6) One of the following courses (3 or 4 credits):				
	CSS	350	Introduction to Plant Genetics	3
	FW	431	Ecophysiology and Toxicology of Fishes	3
	IBIO	328	Comparative Anatomy and Biology of Vertebrates (W)	4
	IBIO	341	Fundamental Genetics	4
Wildlife Biology and Management (26 or 27 credits):				
(1) All of the following courses (9 credits):				
	FW	410	Upland Ecosystem Management	3
	FW	417	Wetland Ecology and Management	3
	FW	413	Wildlife Research and Management Techniques	3
(2) Two of the following courses (8 credits):				
	IBIO	360	Biology of Birds	4
	IBIO	365	Biology of Mammals	4
	IBIO	384	Biology of Amphibians and Reptiles (W)	4
(3) One of the following courses (3 credits):				
	FOR	204	Forest Vegetation	3
	PLB	218	Plants of Michigan	3
	PLB	418	Plant Systematics	3
(4) One of the following courses (3 credits):				

FOR 404 Forest Ecology 3
PLB 105 Plant Biology 3
PLB 203 Biology of Plants 3
PLB 441 Plant Ecology 3
(5)One of the following courses (3 or 4 credits):
CSS 350 Introduction to Plant Genetics 3
IBIO 328 Comparative Anatomy and Biology of Vertebrates (W) 4
IBIO 341 Fundamental Genetics 4

Water Sciences (24 to 28 credits):
(1)Two of the following courses (6 credits):
FW 417 Wetland Ecology and Management 3
FW 420 Stream Ecology 3
FW 472 Limnology 3
(2)The following course (3 credits):
FW 474 Field and Laboratory Techniques for Aquatic Studies 3
(3)One of the following courses (3 credits):
FW 414 Aquatic Ecosystem Management 3
FW 416 Marine Ecosystem Management 3
FW 454 Environmental Hydrology for Watershed Management 3
FW 479 Fisheries Management 3
(4)One of the following courses (3 or 4 credits):
ENT 404 Fundamentals of Entomology 3
ENT 422 Aquatic Entomology 3
FW 471 Ichthyology 4
IBIO 306 Invertebrate Biology 4
(5)One of the following courses (3 or 4 credits):
PLB 418 Plant Systematics 3
PLB 424 Algal Biology 4
(6)Two of the following courses (6 to 8 credits):
CSS 350 Introduction to Plant Genetics 3
FW 431 Ecophysiology and Toxicology of Fishes 3
GLG 421 Environmental Geochemistry 4
MMG 425 Microbial Ecology 3
IBIO 303 Oceanography 4
IBIO 341 Fundamental Genetics 4
IBIO 353 Marine Biology (W) 4

Fish and Wildlife Disease Ecology and Management (30 or 31 credits):
(1)All of the following courses (20 credits):
FW 423 Principles of Fish and Wildlife Disease 3
FW 423L Principles of Fish and Wildlife Disease Laboratory 1
FW 444 Conservation Biology 3
FW 463 Wildlife Disease Ecology 3
IBIO 341 Fundamental Genetics 4
IBIO 445 Evolution (W) 3
MMG 301 Introductory Microbiology 3
(2)One of the following courses (3 or 4 credits):
CEM 143 Survey of Organic Chemistry 4
CEM 251 Organic Chemistry 3
(3)One of the following courses (3 credits):
FW 410 Upland Ecosystem Management 3
FW 414 Aquatic Ecosystem Management 3
FW 416 Marine Ecosystem Management 3
FW 417 Wetland Ecology and Management 3
FW 454 Environmental Hydrology for Watershed Management 3
FW 479 Fisheries Management 3
(4)One of the following courses (4 credits):
FW 471 Ichthyology 4
IBIO 306 Invertebrate Biology 4
IBIO 360 Biology of Birds 4
IBIO 365 Biology of Mammals 4
IBIO 384 Biology of Amphibians and Reptiles (W) 4

Preveterinary (27 or 28 credits):
(1)All of the following courses (24 credits):
BMB 401 Comprehensive Biochemistry 4
CEM 251 Organic Chemistry I 3
CEM 252 Organic Chemistry II 3
CEM 255 Organic Chemistry Laboratory 2
FW 423 Principles of Fish and Wildlife Disease 3
FW 423L Principles of Fish and Wildlife Disease Laboratory 1
FW 463 Wildlife Disease Ecology 3
PHY 251 Introductory Physics Laboratory I 1
PHY 232 Introductory Physics II 3
PHY 252 Introductory Physics Laboratory II 1
(2)One of the following courses (3 or 4 credits):
ANS 314 Genetic Improvement of Domestic Animals 4
ANS 409 Problems, Controversies and Advancements in Reproduction 3
ANS 435 Mammary Physiology 4
ANS 445 Equine Exercise Physiology 4
ANS 455 Avian Physiology 4
BLD 434 Clinical Immunology 3
IBIO 341 Fundamental Genetics 4
IBIO 408 Histology 4
IBIO 425 Cells and Development (W) 4
IBIO 450 Cancer Biology (W) 3
MMG 301 Introductory Microbiology 3
MMG 409 Eukaryotic Cell Biology 3
MMG 451 Immunology 3
NEU 300 Neurobiology 3
PSL 310 Physiology for Pre-Health Professionals 4

APPLIED CONSERVATION BIOLOGY

The Bachelor of Science in Applied Conservation Biology focuses on the science of analyzing and conserving the earth's biological diversity drawing from the biological, physical and social sciences, economics, and the practice of natural resource conservation and management.

Admission as a Junior

To be considered for admission to the major, the student must:

1. Complete at least 56 credits.
2. Complete the following courses with a minimum grade of 2.0 in each course:
   FW 101 Fundamentals of Fisheries and Wildlife Ecology and Management 3
   FW 101L Fundamentals of Fisheries and Wildlife Ecology and Management Lab 2
   FW 293 Undergraduate Seminar in Fisheries and Wildlife 1
3. Pass the following courses:
   a. FW 102 Succeeding in Fisheries and Wildlife – New Student Seminar 1
   b. One of the following courses:
      MTH 124 Survey of Calculus I 3
      MTH 132 Calculus I 3
      LB118 Calculus I 4

Requirements for the Bachelor of Science Degree in Applied Conservation Biology

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 Applied Conservation Biology.
   The University's Tier II writing requirement for the Applied Conservation Biology major is met by completing Fisheries and Wildlife 497 referenced in item 3. below.
   Students who are enrolled in the Applied Conservation Biology major leading to the Bachelor of Science degree in the Department of Fisheries and Wildlife may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing BS 161, BS 162 and CEM 141 below. The completion of BS 171 or BS 172 and CEM 161 satisfies the laboratory requirement. Completion of items 3. a., 3. b., and 3. c. below will be counted toward both the alternative track and the requirements for the major.
   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of item 3. d. and 3. e. below satisfies the College's mathematics requirement.

Students must earn a 2.0 or higher in all FW courses taken to complete major requirements in item 3. below.

Only credits in courses graded on the numerical or Pass-No Grade system may be counted toward the requirements for the major. Students may not enroll in courses required for the major, including courses in other department, on a Credit-No Credit basis. Only elective courses can be enrolled on a Credit-No Credit basis.

3. The following requirements for the major:

				CREDITS
a. All of the following courses (25 credits):				
	FW	101	Fundamentals of Fisheries and Wildlife Ecology and Management	3
	FW	101L	Fundamentals of Fisheries and Wildlife Ecology and Management Lab	2
	FW	102	Fundamentals of Fisheries and Wildlife – New Student Seminar	1
	FW	293	Undergraduate Seminar in Fisheries and Wildlife	1
	FW	334	Human Dimensions of Fisheries and Wildlife Management	3
	FW	364	Ecological Problem Solving	3
	FW	444	Conservation Biology	3
	FW	445	Biodiversity Conservation Policy and Practice	3
	FW	497	Capstone in Fisheries and Wildlife: Conservation and Management Decision Making (W)	3
	IBIO	355	Ecology 3	
b. One of the following groups of courses (6 or 9 credits):				
(a)	BS	161	Cell and Molecular Biology	3
	BS	162	Organismal and Population Biology	3
(b)	LB	144	Biology I: Organismal Biology	4
	LB	145	Biology II: Cellular and Molecular Biology	5
c. One of the following courses (2 credits):				
	BS	171	Cell and Molecular Biology Laboratory	2
	BS	172	Organismal and Population Biology Laboratory	2
	This requirement is waived if students complete LB 144 or LB 145 in item b. 4			
d. One course from each group (5 credits):				
(a)	CEM	141	General Chemistry	4
	LB	171	Principles of Chemistry	4
(b)	CEM	161	Chemistry Laboratory	1
	LB	171L	Principles of Chemistry Laboratory I	1
e. One of the following courses (3 or 4 credits):				
	MTH	124	Survey of Calculus I	3
	MTH	132	Calculus I	3
	LB	118	Calculus I	4
f. One of the following courses (3 or 4 credits):				
	STT	201	Statistical Methods	4
	STT	224	Introduction to Probability and Statistics for Ecologists	3
	STT	231	Statistics for Scientists	3
	STT	421	Statistics I	3
	STT	464	Statistics for Biologists	3
g. One of the following courses (3 or 4 credits):				
	CSUS	310	History of Environmental Thought and Sustainability	3
	FW	439	Conservation Ethics	3
	HST	391	Environmental History of North America	3
	PHL	340	Ethics	3
	PHL	342	Environmental Ethics	3
	PHL	380	Nature of Science	3
	PHL	442	Ethics and Animals	3
	PHL	480	Philosophy of Science	4
h. Two of the following courses (6 or 7 credits):				
	COM	100	Human Communication	3
	COM	225	An Introduction to Interpersonal Communication	3
	COM	240	Introduction to Organizational Communication	4
	COM	275	Effects of Mass Communication	3
	CSUS	433	Grant Writing and Fund Development	3
	JRN	472	Environmental, Science and Health Reporting	3
	WRA	331	Writing in the Public Interest (W)	3
	WRA	333	Writing in Corporate Contexts	3
	WRA	335	Writing in Scientific Contexts	3
	WRA	337	Writing and Public Policy	3
	WRA	453	Grant and Proposal Writing	3
i. One of the following courses (3 credits):				
	FW	424	Wildlife Population Analysis and Management	3
	FW	479	Fisheries Population Analysis and Management	3
j. One of the following courses (3 or 4 credits):				
	FOR	419	Applications of Geographic Information Systems to Natural Resources Management	4
	FW	413	Wildlife Research and Management Techniques	3
	FW	474	Field and Laboratory Techniques for Aquatic Studies	3
	GEO	221	Introduction to Geographic Information	3
	And			
	GEO	221L	Introduction to Geographic Information Laboratory	1
k. One of the following courses (3 or 4 credits):				
	CSS	350	Introduction to Plant Genetics	3
	IBIO	341	Fundamental Genetics	4
l. One of the following courses (3 or 4 credits):				
	IBIO	445	Evolution (W)	3
	GLG	304	Physical and Biological History of the Earth	4
	GLG	434	Evolutionary Paleobiology	4
m. One of the following courses (3 or 4 credits):				
	FOR	340	Forest Ecology	3
	FW	420	Stream Ecology	3
	FW	472	Limnology	3
	IBIO	353	Marine Biology (W)	4
	IBIO	485	Tropical Biology	3
	PLB	441	Plant Ecology	3
n. One of the following courses (3 credits):				
	CSUS	464	Environmental and Natural Resource Policy in Michigan	3
	CSUS	465	Environmental and Natural Law	3
	FOR	466	Natural Resource Policy	3
	FW	481	Global Issues in Fisheries and Wildlife	3
	IBIO	446	Environmental Issues in Public Policy	3
	MC	450	International Environmental Law and Policy	3
o. One of the following courses (3 credits):				
	FOR	413	Wildland Fire Ecology and Management	3
	FW	410	Upland Ecology and Management	3
	FW	416	Marine Ecology and Management	3
	FW	417	Wetland Ecology ad Management	3
	FW	423	Principles of Fish and Wildlife Disease	3
	FW	463	Wildlife Disease Ecology	3
	PLB	443	Restoration Ecology	3
p. One of the following courses (3 credits):				
	ANP	443	Human Adaptability	3
	ANP	486	Environmental Archaeology	3
	FOR	360	Forest Ecosystems, Carbon and Climate Change	3
	GEO	409	Global Climate Change and Variability	3
	IBIO	357	Global Change Biology (W)	3
	SOC	478	Climate Change and Society	3
q. Two of the following courses (6 to 8 credits):				
	ENT	404	Fundamentals of Entomology	4
	ENT	422	Aquatic Entomology	3
	FOR	204	Forest Vegetation	3
	FW	471	Ichthyology	4
	IBIO	306	Invertebrate Biology	4
	IBIO	360	Biology of Birds	4
	IBIO	365	Biology of Mammals	4
	IBIO	384	Biology of Amphibians and Reptiles (W)	4
	PLB	218	Plants of Michigan	3
	PLB	418	Plant Systematics	3
r. Complete a minimum of 3 credits from the following courses (3 or 4 credits):				
	FW	480	International Studies in Fisheries and Wildlife	1 to 3
	FW	490	Independent Study in Fisheries and Wildlife	1 to 3
	FW	493	Professional Internship in Fisheries and Wildlife	1 to 3
	FW	499	Senior Thesis in Fisheries and Wildlife	4

AQUATIC ECOLOGY AND MANAGEMENT

The Bachelor of Science in Aquatic Ecology and Management is designed for students interested in examining the biological, physical, chemical, geological and hydrological aspects of lakes and ponds, rivers and streams, wetlands and groundwaters, with an emphasis on water quality. This major provides students with the understanding and skills needed for careers related to protecting and restoring water resources around the North American Great Lakes region and the world.

Admission as a Junior

To be considered for admission to the major, the student must:

1. Complete at least 56 credits.
2. Complete the following courses with a minimum grade of 2.0 in each course:
   - FW 101 Fundamentals of Fisheries and Wildlife Ecology and Management 3
   - FW 101L Fundamentals of Fisheries and Wildlife Ecology and Management Lab 2
   - FW 293 Undergraduate Seminar in Fisheries and Wildlife 1
3. Pass the following courses:
   - a. FW 102 Succeeding in Fisheries and Wildlife – New Student Seminar 1
   - b. One of the following courses:
     - MTH 124 Survey of Calculus I 3
     - MTH 132 Calculus I 3
     - LB118 Calculus I 4

Requirements for the Bachelor of Science Degree in Aquatic Ecology and Management

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 Aquatic Ecology and Management.
   The University's Tier II writing requirement for the Aquatic Ecology and Management major is met by completing Fisheries and Wildlife 497 referenced in item 3. below.
   Students who are enrolled in the Aquatic Ecology and Management major leading to the Bachelor of Science degree in the Department of Fisheries and Wildlife may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing BS 161, BS 162 and CEM 141 below. The completion of BS 171 or BS 172 and CEM 161 satisfies the laboratory requirement. Completion of items 3. a., 3. b., and 3. c. below will be counted toward both the alternative track and the requirements for the major.
   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.
   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of item 3. d. and 3. e. below satisfies the College's mathematics requirement.
   Students must earn a 2.0 or higher in all FW courses taken to complete major requirements in item 3. below.
   Only credits in courses graded on the numerical or Pass-No Grade system may be counted toward the requirements for the major. Students may not enroll in courses required for the major, including courses in other department, on a Credit-No Credit basis. Only elective courses can be enrolled on a Credit-No Credit basis.
3. The following requirements for the major:

CREDITS

a. All of the following courses (22 credits):
   - FW 101 Fundamentals of Fisheries and Wildlife Ecology and Management 3
   - FW 101L Fundamentals of Fisheries and Wildlife Ecology and Management Lab 2
   - FW 102 Fundamentals of Fisheries and Wildlife – New Student Seminar 1
   - FW 293 Undergraduate Seminar in Fisheries and Wildlife 1
   - FW 334 Human Dimensions of Fisheries and Wildlife Management 3
   - FW 364 Ecological Problem Solving 3
   - FW 497 Capstone in Fisheries and Wildlife: Conservation and Management Decision Making (W) 3
   - IBIO 355 Ecology 3
   - MMG201 Fundamentals of Microbiology 3

b. One of the following groups of courses (6 or 9 credits):
   - (a) BS 161 Cell and Molecular Biology 3
     BS 162 Organismal and Population Biology 3
   - (b) LB 144 Biology I: Organismal Biology 4
     LB 145 Biology II: Cellular and Molecular Biology 5

c. One course from each group (5 credits):
   - (a) CEM 141 General Chemistry 4
     LB 171 Principles of Chemistry 4
   - (b) CEM 161 Chemistry Laboratory 1
     LB 171L Principles of Chemistry Laboratory I 1

d. One of the following courses (2 credits):
   - BS 171 Cell and Molecular Biology Laboratory 2
   - BS 172 Organismal and Population Biology Laboratory 2

   This requirement is waived if students complete LB 144 or LB 145 in item b.

e. One of the following courses (3 or 4 credits):
   - LB 273 Physics I 4
   - PHY 221 Studio Physics for Life Scientists I 4
   - PHY 231 Introductory Physics I 3

f. One of the following courses (3 or 4 credits):
   - MTH 124 Survey of Calculus I 3
   - MTH 132 Calculus I 3
   - LB 118 Calculus I 4

g. One of the following courses (3 or 4 credits):
   - STT 201 Statistical Methods 4
   - STT 224 Introduction to Probability and Statistics for Ecologists 3
   - STT 231 Statistics for Scientists 3
   - STT 421 Statistics I 3
   - STT 464 Statistics for Biologists 3

h. One of the following courses (3 or 4 credits):
   - CSUS310 History of Environmental Thought and Sustainability 3
   - FW 439 Conservation Ethics 3
   - HST 391 Environmental History of North America 3
   - PHL 340 Ethics 3
   - PHL 342 Environmental Ethics 3
   - PHL 380 Nature of Science 3
   - PHL 442 Ethics and Animals 3
   - PHL 480 Philosophy of Science 4

i. Two of the following courses (6 or 7 credits):
   - COM 100 Human Communication 3
   - COM 225 An Introduction to Interpersonal Communication 3
   - COM 240 Introduction to Organizational Communication 4
   - COM 275 Effects of Mass Communication 3
   - CSUS433 Grant Writing and Fund Development 3
   - JRN 472 Environmental, Science and Health Reporting 3
   - WRA 331 Writing in the Public Interest (W) 3
   - WRA 333 Writing in Corporate Contexts 3
   - WRA 335 Writing in Scientific Contexts 3
   - WRA 337 Writing and Public Policy 3
   - WRA 453 Grant and Proposal Writing 3

j. Two of the following courses (6 credits):
   - CSUS354 Water Resources Management 3
   - FW 207 Great Lakes: Biology and Management 3
   - FW 416 Marine Ecology and Management 3
   - FW 417 Wetland Ecology and Management 3

k. Two of the following courses (6 or 7 credits):
   - FW 420 Stream Ecology 3
   - FW 472 Limnology 3
   - GLG 303 Oceanography 3
   - IBIO 353 Marine Biology (W) 4
   - MMG425 Microbial Ecology 3

l. One of the following courses (3 or 4 credits):
   - EPI 390 Disease in Society: Introduction to Epidemiology and Public Health 4
   - FW 423 Principles of Fish and Wildlife Disease 3
   - FW 431 Ecophysiology and Toxicology of Fishes 3
   - FW 463 Wildlife Disease Ecology 3

m. One of the following courses (3 or 4 credits):
   - CSS 455 Environmental Pollutants in Soil and Water 3
   - GEO 411 Stream Systems and Landforms 3
   - GLG 411 Hydrogeology 3
   - GLG 421 Environmental Geochemistry 4

n. One of the following courses (3 or 4 credits):
   - FOR 419 Applications of Geographic Information Systems to Natural Resources Management 4
   - FW 474 Field and Laboratory Techniques for Aquatic Studies 3
   - FW 479 Fish Population Analysis and Management 3
   - GEO 221 Introduction to Geographic Information 3

   and
   - GEO 221L Introduction to Geographic Information Laboratory 1
   - GLG 446 Ecosystems Modeling, Water and Food Security 3

o. One of the following courses (3 credits):

CSUS464	Environmental and Natural Resource Policy in Michigan	3
CSUS465	Environmental and Natural Law	3
FOR 466	Natural Resource Policy	3
FW 445	Biodiversity Conservation Policy and Practice	3
FW 481	Global Issues in Fisheries and Wildlife	3
IBIO 446	Environmental Issues in Public Policy	3
MC 450	International Environmental Law and Policy	3

p. One of the following courses (3 credits):

ANP 443	Human Adaptability	3
ANP 486	Environmental Archaeology	3
FOR 360	Forest Ecosystems, Carbon and Climate Change	3
GEO 409	Global Climate Change and Variability	3
IBIO 357	Global Change Biology (W)	3
SOC 478	Climate Change and Society	3

q. Complete a minimum of 3 credits from the following courses (3 or 4 credits):

FW 480	International Studies in Fisheries and Wildlife	1 to 3
FW 490	Independent Study in Fisheries and Wildlife	1 to 3
FW 493	Professional Internship in Fisheries and Wildlife	1 to 3
FW 499	Senior Thesis in Fisheries and Wildlife	4

FISH ECOLOGY AND MANAGEMENT

The Bachelor of Science in Fish Ecology and Management is designed for students interested in the research and management of fish populations, other freshwater and marine organisms, and the ecosystems that sustain them.?

Admission as a Junior

To be considered for admission to the major, the student must:

1. Complete at least 56 credits.
2. Complete the following courses with a minimum grade of 2.0 in each course:

FW 101	Fundamentals of Fisheries and Wildlife Ecology and Management	3
FW 101L	Fundamentals of Fisheries and Wildlife Ecology and Management Lab	2
FW 293	Undergraduate Seminar in Fisheries and Wildlife	1

3. Pass the following courses:

a. FW 102 Succeeding in Fisheries and Wildlife – New Student Seminar 1

b. One of the following courses:

MTH 124	Survey of Calculus I	3
MTH 132	Calculus I	3
LB118	Calculus I	4

Requirements for the Bachelor of Science Degree in Fish Ecology and Management

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 Fish Ecology and Management.

   The University's Tier II writing requirement for the Fish Ecology and Management major is met by completing Fisheries and Wildlife 497 referenced in item 3. below.

   Students who are enrolled in the Fish Ecology and Management major leading to the Bachelor of Science degree in the Department of Fisheries and Wildlife may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing BS 161, BS 162 and CEM 141 below. The completion of BS 171 or BS 172 and CEM 161 satisfies the laboratory requirement. Completion of items 3. a., 3. b., and 3. c. below will be counted toward both the alternative track and the requirements for the major.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of item 3. d. and 3. e. below satisfies the College's mathematics requirement.

   Students must earn a 2.0 or higher in all FW courses taken to complete major requirements in item 3. below.

   Only credits in courses graded on the numerical or Pass-No Grade system may be counted toward the requirements for the major. Students may not enroll in courses required for the major, including courses in other department, on a Credit-No Credit basis. Only elective courses can be enrolled on a Credit-No Credit basis.
3. The following requirements for the major:

CREDITS

a. All of the following courses (29 credits):

FW 101	Fundamentals of Fisheries and Wildlife Ecology and Management	3
FW 101L	Fundamentals of Fisheries and Wildlife Ecology and Management Lab	2
FW 102	Fundamentals of Fisheries and Wildlife – New Student Seminar	1
FW 293	Undergraduate Seminar in Fisheries and Wildlife	1
FW 334	Human Dimensions of Fisheries and Wildlife Management	3
FW 364	Ecological Problem Solving	3
FW 471	Ichthyology	3
FW 474	Field and Laboratory Techniques for Aquatic Studies	3
FW 479	Fish Population Analysis and Management	3
FW 497	Capstone in Fisheries and Wildlife: Conservation and Management Decision Making (W)	3
IBIO 355	Ecology	3

b. One of the following groups of courses (6 or 9 credits):

(a)	BS 161	Cell and Molecular Biology	3
	BS 162	Organismal and Population Biology	3
(b)	LB 144	Biology I: Organismal Biology	4
	LB 145	Biology II: Cellular and Molecular Biology	5

c. One of the following courses (2 credits):

BS 171	Cell and Molecular Biology Laboratory	2
BS 172	Organismal and Population Biology Laboratory	2

This requirement is waived if students complete LB 144 or LB 145 in item b. 4

d. One course from each group (5 credits):

(a)	CEM 141	General Chemistry	4
	LB 171	Principles of Chemistry	4
(b)	CEM 161	Chemistry Laboratory	1
	LB 171L	Principles of Chemistry Laboratory I	1

e. At least 7 credits from the following courses:

CEM 142	General and Inorganic Chemistry	3
CEM 162	Chemistry Laboratory II	1
CEM 143	Survey of Organic Chemistry	4
CEM 251	Organic Chemistry I	3
CSS 210	Fundamentals of Soil Science	3
FOR 419	Applications of Geographic Information Systems to Natural Resources Management	4
GEO 203	Introduction to Meteorology	3
GEO 206	Physical Geography	3
GEO 208	Physical Geography of the National Parks	2
GEO 221	Introduction to Geographic Information	3
GEO 221L	Introduction to Geographic Information Laboratory	1
GEO 333	Geography of Michigan and the Great Lakes Region	3
GEO 411	Stream Systems and Landforms	3
GLG 201	The Dynamic Earth	4
GLG 411	Hydrogeology	3
LB 172	Principles of Chemistry II	3
LB 172L	Principles of Chemistry II – Reactivity Laboratory I	1
LB 271	Organic Chemistry	3
LB 273	Physics I	4
PHY 221	Studio Physics for Life Scientists I	4
PHY 231	Introductory Physics I	3
PHY 251	Introductory Physics Laboratory I	1

Students who select FOR 419 to fulfill this requirement may not also use GEO 221 and 221L.

f. One of the following courses (3 or 4 credits):

MTH 124	Survey of Calculus I	3
MTH 132	Calculus I	3
LB 118	Calculus I	4

g. One of the following courses (3 or 4 credits):

STT 201	Statistical Methods	4
STT 224	Introduction to Probability and Statistics for Ecologists	3

	STT 231	Statistics for Scientists	3
	STT 421	Statistics I	3
	STT 464	Statistics for Biologists	3
h.	One of the following courses (3 or 4 credits):		
	CSUS310	History of Environmental Thought and Sustainability	3
	FW 439	Conservation Ethics	3
	HST 391	Environmental History of North America	3
	PHL 340	Ethics	3
	PHL 342	Environmental Ethics	3
	PHL 380	Nature of Science	3
	PHL 442	Ethics and Animals	3
	PHL 480	Philosophy of Science	4
i.	Two of the following courses (6 or 7 credits):		
	COM 100	Human Communication	3
	COM 225	An Introduction to Interpersonal Communication	3
	COM 240	Introduction to Organizational Communication	4
	COM 275	Effects of Mass Communication	3
	CSUS433	Grant Writing and Fund Development	3
	JRN 472	Environmental, Science and Health Reporting	3
	WRA 331	Writing in the Public Interest (W)	3
	WRA 333	Writing in Corporate Contexts	3
	WRA 335	Writing in Scientific Contexts	3
	WRA 337	Writing and Public Policy	3
	WRA 453	Grant and Proposal Writing	3
j.	One of the following courses (3 credits):		
	CSUS464	Environmental and Natural Resource Policy in Michigan	3
	CSUS465	Environmental and Natural Law	3
	FOR 466	Natural Resource Policy	3
	FW 445	Biodiversity Conservation Policy and Practice	3
	FW 481	Global Issues in Fisheries and Wildlife	3
	IBIO 446	Environmental Issues in Public Policy	3
	MC 450	International Environmental Law and Policy	3
k.	Two of the following courses (6 credits):		
	CSUS354	Water Resources Management	3
	FW 416	Marine Ecology and Management	3
	FW 417	Wetland Ecology and Management	3
	FW 420	Stream Ecology	3
	FW 472	Limnology	3
	GLG 303	Oceanography	3
l.	One of the following courses (3 or 4 credits):		
	PLB 218	Plants of Michigan	3
	PLB 418	Plant Systematics	3
	ENT 404	Fundamentals of Entomology	4
	ENT 422	Aquatic Entomology	3
	IBIO 306	Invertebrate Biology	4
m.	One of the following courses (3 or 4 credits):		
	FW 423	Principles of Fish and Wildlife Disease	3
	FW 431	Ecophysiology and Toxicology of Fishes	3
	FW 463	Wildlife Disease Ecology	3
	IBIO 313	Animal Behavior	3
	IBIO 328	Comparative Anatomy and Biology of Vertebrates	4
	IBIO 341	Fundamental Genetics	4
	IBIO 483	Environmental Physiology	3
n.	One of the following courses (3 credits):		
	ANP 443	Human Adaptability	3
	ANP 486	Environmental Archaeology	3
	FOR 360	Forest Ecosystems, Carbon and Climate Change	3
	GEO 409	Global Climate Change and Variability	3
	IBIO 357	Global Change Biology (W)	3
	SOC 478	Climate Change and Society	3
o.	Complete a minimum of 3 credits from the following courses (3 or 4 credits):		
	FW 480	International Studies in Fisheries and Wildlife	1 to 3
	FW 490	Independent Study in Fisheries and Wildlife	1 to 3
	FW 493	Professional Internship in Fisheries and Wildlife	1 to 3
	FW 499	Senior Thesis in Fisheries and Wildlife	4

WILDLIFE ECOLOGY AND MANAGEMENT

The Bachelor of Science in Wildlife Ecology and Management is for students interested in understanding and managing terrestrial habitats and animals including game, non-game, and endangered species.?

Admission as a Junior

To be considered for admission to the major, the student must:

1. Complete at least 56 credits.
2. Complete the following courses with a minimum grade of 2.0 in each course:
   - FW 101 Fundamentals of Fisheries and Wildlife Ecology and Management 3
   - FW 101L Fundamentals of Fisheries and Wildlife Ecology and Management Lab 2
   - FW 293 Undergraduate Seminar in Fisheries and Wildlife 1
3. Pass the following courses:
   - a. FW 102 Succeeding in Fisheries and Wildlife – New Student Seminar 1
   - b. One of the following courses:
     - MTH 124 Survey of Calculus I 3
     - MTH 132 Calculus I 3
     - LB118 Calculus I 4

Requirements for the Bachelor of Science Degree in Wildlife Ecology and Management

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 Wildlife Ecology and Management.

   The University's Tier II writing requirement for the Wildlife Ecology and Management major is met by completing Fisheries and Wildlife 497 referenced in item 3. below.

   Students who are enrolled in the Wildlife Ecology and Management major leading to the Bachelor of Science degree in the Department of Fisheries and Wildlife may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing BS 161, BS 162 and CEM 141 below. The completion of BS 171 or BS 172 and CEM 161 satisfies the laboratory requirement. Completion of items 3. a., 3. b., and 3. c. below will be counted toward both the alternative track and the requirements for the major.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of item 3. d. and 3. e. below satisfies the College's mathematics requirement.

   Students must earn a 2.0 or higher in all FW courses taken to complete major requirements in item 3. below.

   Only credits in courses graded on the numerical or Pass-No Grade system may be counted toward the requirements for the major. Students may not enroll in courses required for the major, including courses in other department, on a Credit-No Credit basis. Only elective courses can be enrolled on a Credit-No Credit basis.
3. The following requirements for the major:

			CREDITS
a.	All of the following courses (34 credits):		
	CSS 210	Fundamentals of Soil Science	3
	FW 101	Fundamentals of Fisheries and Wildlife Ecology and Management	3
	FW 101L	Fundamentals of Fisheries and Wildlife Ecology and Management Lab	2
	FW 102	Fundamentals of Fisheries and Wildlife – New Student Seminar	1
	FW 293	Undergraduate Seminar in Fisheries and Wildlife	1
	FW 334	Human Dimensions of Fisheries and Wildlife Management	3
	FW 364	Ecological Problem Solving	3
	FW 410	Upland Ecology and Management	3
	FW 413	Wildlife Research and Management Techniques	3
	FW 417	Wetland Ecology and Management	3
	FW 424	Wildlife Population Analysis and Management	3
	FW 497	Capstone in Fisheries and Wildlife: Conservation and Management Decision Making (W)	3
	IBIO 355	Ecology 3	
b.	One of the following groups of courses (6 or 9 credits):		

(a) BS 161 Cell and Molecular Biology 3
BS 162 Organismal and Population Biology 3
(b) LB 144 Biology I: Organismal Biology 4
LB 145 Biology II: Cellular and Molecular Biology 5

c. One of the following courses (2 credits):
BS 171 Cell and Molecular Biology Laboratory 2
BS 172 Organismal and Population Biology Laboratory 2
This requirement is waived if students complete LB 144 or LB 145 in item b.

d. One course from each group (5 credits):
(a) CEM 141 General Chemistry 4
LB 171 Principles of Chemistry 4
(b) CEM 161 Chemistry Laboratory 1
LB 171L Principles of Chemistry Laboratory I 1

e. One of the following courses (3 or 4 credits):
MTH 124 Survey of Calculus I 3
MTH 132 Calculus I 3
LB 118 Calculus I 4

f. One of the following courses (3 or 4 credits):
STT 201 Statistical Methods 4
STT 224 Introduction to Probability and Statistics for Ecologists 3
STT 231 Statistics for Scientists 3
STT 421 Statistics I 3
STT 464 Statistics for Biologists 3

g. One of the following courses (3 or 4 credits):
CSUS310 History of Environmental Thought and Sustainability 3
FW 439 Conservation Ethics 3
HST 391 Environmental History of North America 3
PHL 340 Ethics 3
PHL 342 Environmental Ethics 3
PHL 380 Nature of Science 3
PHL 442 Ethics and Animals 3
PHL 480 Philosophy of Science 4

h. Two of the following courses (6 or 7 credits):
COM 100 Human Communication 3
COM 225 An Introduction to Interpersonal Communication 3
COM 240 Introduction to Organizational Communication 4
COM 275 Effects of Mass Communication 3
CSUS433 Grant Writing and Fund Development 3
JRN 472 Environmental, Science and Health Reporting 3
WRA 331 Writing in the Public Interest (W) 3
WRA 333 Writing in Corporate Contexts 3
WRA 335 Writing in Scientific Contexts 3
WRA 337 Writing and Public Policy 3
WRA 453 Grant and Proposal Writing 3

i. One of the following courses (3 credits):
CSUS464 Environmental and Natural Resource Policy in Michigan 3
CSUS465 Environmental and Natural Law 3
FOR 466 Natural Resource Policy 3
FW 445 Biodiversity Conservation Policy and Practice 3
FW 481 Global Issues in Fisheries and Wildlife 3
IBIO 446 Environmental Issues in Public Policy 3
MC 450 International Environmental Law and Policy 3

j. Two of the following courses (8 credits):
FW 471 Ichthyology 4
IBIO 360 Biology of Birds 4
IBIO 365 Biology of Mammals 4
IBIO 384 Biology of Amphibians and Reptiles 4

k. One of the following courses (3 or 4 credits):
FOR 204 Forest Vegetation 3
PLB 218 Plants of Michigan 3
PLB 418 Plant Systematics 3

l. One of the following courses (3 or 4 credits):
CSS 350 Introduction to Plant Genetics 3
FOR 340 Forest Ecology 3
GEO 201 Introduction to Plant Geography 3
IBIO 485 Tropical Biology 3
PLB 105 Plant Biology 3
PLB 301 Introductory Plant Physiology 3
PLB 402 Biology of Fungi 4
PLB 441 Plant Ecology 3
PLB 443 Restoration Ecology 3

m. One of the following courses (3 or 4 credits):
CSS 411 Fire and Environmental Quality 3
FOR 413 Wildland Fire Ecology and Management 3
FOR 419 Applications of Geographic Information Systems to Natural Resources Management 4
FW 423 Principles of Fish and Wildlife Disease 3
FW 463 Wildlife Disease Ecology 3
GEO 221 Introduction to Geographic Information 3
and
GEO 221L Introduction to Geographic Information Laboratory 1
IBIO 313 Animal Behavior 3
IBIO 328 Comparative Anatomy and Biology of Vertebrates 4
IBIO 341 Fundamental Genetics 4
IBIO 483 Environmental Physiology 3
SOC 452 Advanced Seminar in Environmental Sociology 3

n. One of the following courses (3 credits):
ANP 443 Human Adaptability 3
ANP 486 Environmental Archaeology 3
FOR 360 Forest Ecosystems, Carbon and Climate Change 3
GEO 409 Global Climate Change and Variability 3
IBIO 357 Global Change Biology (W) 3
SOC 478 Climate Change and Society 3

o. Complete a minimum of 3 credits from the following courses (3 or 4 credits):
FW 480 International Studies in Fisheries and Wildlife 1 to 3
FW 490 Independent Study in Fisheries and Wildlife 1 to 3
FW 493 Professional Internship in Fisheries and Wildlife 1 to 3
FW 499 Senior Thesis in Fisheries and Wildlife 4

MINOR IN CONSERVATION, RECREATION AND ENVIRONMENTAL ENFORCEMENT

The Minor in Conservation, Recreation and Environmental Enforcement is designed to combine the natural resource expertise of the fisheries and wildlife, forestry, parks, recreation and tourism, and environmental sustainability programs, with the law enforcement expertise of the criminal justice program to serve those students with career interests in conservation, recreation or environmental law enforcement. The minor is available as an elective to students who are enrolled in bachelor's degree programs in criminal justice, fisheries and wildlife, forestry, parks, recreation and tourism and environmental studies and sustainability. The minor is administered by the Department of Fisheries and Wildlife.

Students who are interested in enrolling should apply to the Department of Fisheries and Wildlife for acceptance. With the approval of the department and college that administer the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Conservation, Recreation and Environmental Enforcement

The student must complete (19 to 20 credits):

CREDITS

1. Complete both of the following courses (4 credits):
CJ 110 Introduction to Criminal Justice 3
CSUS 278 Introduction to Conservation, Recreation and Environmental Enforcement 1

Natural Resources Conservation and Management 6 or 7

1. One of the following courses (3 credits):
CSUS 200 Introduction to Sustainability 3
CSUS 276 Sustaining our National Parks and Recreation Lands 3
FOR 202 Introduction to Forestry 3
FW 101 Fundamentals of Fisheries and Wildlife 3

2. One of the following courses (3 or 4 credits):
CSUS 320 Environmental Planning and Management 3
CSUS 476 Natural Resource Recreation Management 4
FW 444 Conservation Biology 3
FW 481 Global Issues in Fisheries and Wildlife 3

Environmental Attitudes, Policy and Law 3

1. One of the following courses (3 credits):
CSUS 310 History of Environmental Thought and Sustainability 3

CSUS	464	Environmental and Natural Resource Policy in Michigan	3
CSUS	465	Environmental and Natural Resource Law	3
FOR	330	Human Dimensions of Forests	3
FOR	466	Natural Resource Policy	3
FW	434	Human Dimensions of Fisheries and Wildlife Management (W)	3
FW	445	Biodiversity Conservation Policy and Practice	3
IBIO	446	Environmental Issues and Public Policy	3
MC	450	International Environmental Law and Policy	3
SOC	452	Environment and Society	3

Law Enforcement 6

1. Two of the following courses (6 credits):

CJ	210	Introduction to Forensic Science	3
CJ	220	Criminology	3
CJ	235	Investigation Procedures	3
CJ	275	Criminal Procedure	3
CJ	335	Policing	3
CJ	432	Community Policing	3

MINOR IN MARINE ECOSYSTEM MANAGEMENT

The Minor in Marine Ecosystem Management is designed to provide students with a fundamental background in ecosystem management of marine natural resources. Students gain insight and experience in marine management issues relative to estuarine, coastal, and open-water marine ecosystems from the perspective of habitat, biota and human resource users. Students are also exposed to the management skills necessary to recognize and use effective techniques to conserve, preserve and restore marine ecosystem integrity for the benefit of society. This unique management emphasis serves the career interests of students well as they pursue positions in the marine sciences.

The Minor in Marine Ecosystem Management is available as an elective to students who are enrolled in Bachelor of Science degree programs with majors in Fisheries and Wildlife, and Zoology. The minor is administered by the Department of Fisheries and Wildlife. With the approval of the department and college that administer the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Students who plan to complete the requirements for the marine ecosystem management minor should contact the undergraduate advisor for fisheries and wildlife in the Department of Fisheries and Wildlife.

Requirements for the Minor in Marine Ecosystem Management

The student must complete:

			CREDITS
Marine Ecosystem Management			
All of the following courses (14 credits):			
FW	110	Conservation and Management of Marine Resources	3
FW	416	Marine Ecosystem Management	3
IBIO	303	Oceanography	4
IBIO	353	Marine Biology (W)	4
Biodiversity			
One of the following courses 3 or 4 credits):			
FW	471	Ichthyology	4
IBIO	306	Invertebrate Biology	4
PLB	424	Algal Biology	3
Experiential Learning in Marine Ecosystem Management			
One of the following courses which must contain a marine emphasis (2 to 4 credits):			
FW	480	International Studies in Fisheries and Wildlife	3
FW	493	Professional Internships in Fisheries and Wildlife	2 or 3
IBIO	496	Internship in Zoology	4
IBIO	498	Internship in Zoo and Aquarium Science	4

GRADUATE STUDY

The mission of the Fisheries and Wildlife department is to build local, national, and international capacities to conserve ecosystems that support fish, wildlife, and society through integrated programs in research, education and engagement. The department's faculty, students and staff address a wide range of research themes that fall along spectrums of disciplinary expertise, scientific approaches to understanding, collaborators, funding sources, and stakeholder groups. Our expertise ranges from disciplinary areas with a long-standing history in the domain of fisheries and wildlife to those emerging more recently. Collectively, we are tackling challenges and developing solutions in areas including, but not limited to: managing for sustainable harvest of fisheries and wildlife populations, developing sound governance structures and effective policies, assessing the ecological status of animal populations and their ecosystems at broad geographic scales, incorporating the diverse ways that humans use and value natural resources into management processes and decisions, and understanding and responding to emerging infectious diseases, global climate change, human-wildlife conflict, wildlife trafficking, environmental toxins, and invasive species.

The department's graduate program is a national leader in the training of students for careers in research, management, teaching, extension and consulting. The Department of Fisheries and Wildlife offers a thesis or non-thesis Master of Science (M.S.) degree and a Doctoral (Ph.D.) degree in Fisheries and Wildlife. Required courses are few, allowing for programs of study that reflect diverse student interests and skill-building opportunities. Consistent with our commitment to the application of our work to improve natural resource conservation and stewardship, all our graduate students are required to conduct an outreach project or enroll in an outreach course. Graduates of our master's program are hired by a variety of local, state and federal governmental agencies, private corporations, museums, zoos and nature centers, tribal organizations, and environmental consulting firms. Ph.D. graduates are employed on the faculty of leading universities and compete successfully for positions outside of academia, such as research positions with federal agencies. Approximately 100 graduate students are currently enrolled, the majority of whom receive financial assistance in the form of graduate assistantships.

Graduate student research projects span the department's diverse disciplinary areas. These projects take advantage of modern computing facilities, a world-class library, university research stations, laboratory facilities, and department relationships with a global network of scientists, management agencies, and stakeholder groups. Whereas many of our graduate students address research questions applied to the natural resources of Michigan, many are involved in projects of national and international scope. Our students present their research results to a wide range of regional, national and international audiences.

The Department of Fisheries and Wildlife offers Master of Science and Doctor of Philosophy degree programs in fisheries and wildlife. Students in the Master of Science degree program in fisheries and wildlife are eligible for the dual JD program with Michigan State University - College of Law. Doctoral students may pursue interdepartmental dual degrees in Ecology, Evolution and Behavior or Environmental Science and Policy. For additional information, refer to the statements in *Environmental Science and Policy – Dual Major* and *Ecology, Evolution and Behavior – Dual Major* in this catalog.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of Fisheries and Wildlife may elect specializations in environmental and resource economics, fish and wildlife disease ecology and conservation medicine, and gender, justice and environmental change. For additional information, refer to the statements on *Interdepartmental Graduate Specializations in Environmental and Resource Economics*, *Graduate Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine*, and the *Graduate Specialization in Gender, Justice, and Environmental Change* in this catalog.

FISHERIES AND WILDLIFE

Programs of study are based on the academic preparation, interests, and career goals of individual students. Although individual students' programs vary, all Master of Science programs in fisheries and wildlife are designed to provide preparation in one of the areas of specialization within the field of fisheries and wildlife, broad preparation in related areas, and a foundation for fisheries and wildlife related careers in administration, research, and management.

Master of Science

In addition to meeting the requirements of the university and of College of Agriculture and Natural Resources, the student must meet the requirements specified below.

Admission

Admission to a master's program requires prior completion of an undergraduate major in a biological or other appropriate science with course work appropriate to support the graduate program. Students lacking sufficient courses may be admitted provisionally until such deficiencies are removed by completing collateral courses. Scores on the Graduate Record Examination General Test are required.

Requirements for the Master of Science Degree in Fisheries and Wildlife

The student may elect either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under either Plan A or Plan B. The student and the major professor plan a program of study that includes FW 894 and courses related to one or more areas of specialization within the field of fisheries and wildlife. Students are required to plan and execute a departmentally approved outreach experience, or in lieu of this, include FW 895 in their approved program. The program must be approved by the student's guidance committee which includes at least two members in addition to the major professor, at least one of which is from the Department of Fisheries and Wildlife.

Doctor of Philosophy

In addition to meeting the requirements of the university and of College of Agriculture and Natural Resources, the student must meet the requirements specified below.

Admission

Applicants for a doctoral program should have completed a Bachelor of Science degree in a biological or other appropriate science. For some areas of specialization, additional background in mathematics, chemistry, botany, zoology or a related Master of Science degree is desirable. Scores on the Graduate Record Examination General Test are required.

Requirements for the Doctor of Philosophy Degree in Fisheries and Wildlife

The student and the major professor plan a program of study that includes FW 894 and courses related to one or more areas of specialization within the field of fisheries and wildlife. Students are required to plan and execute a departmentally approved outreach experience, or in lieu of, include FW 895 in their approved program. The program must be approved by the student's guidance committee, which includes at least three members in addition to the major professor, at least one of whom is from a department other than Fisheries and Wildlife and at least one of whom is from the Department of Fisheries and Wildlife.

GRADUATE CERTIFICATE IN CONSERVATION LAW

The Graduate Certificate in Conservation Law provides students an opportunity to explore conservation law by gaining familiarity with the language, theory and practices of the law discipline to better integrate their core education with their respective environmental or conservation-related disciplinary field.

The graduate certificate is available as an elective to students who are enrolled in master's or doctoral degree programs at Michigan State University.

Requirements for the Graduate Certificate in Conservation Law

	CREDITS
Students must complete both of the following courses (9 credits):	
LAW 630M Conservation Law Clinic I	6
LAW 630N Conservation Law Clinic II	3

DEPARTMENT of FOOD SCIENCE and HUMAN NUTRITION

Leslie D. Bourquin, Chairperson

The mission of the department of Food Science and Human Nutrition is to advance human health through excellent teaching, research, and outreach programs in the disciplines of food science and human nutrition. Our faculty address contemporary issues related to global food safety, quality, food product development, and production as well as nutrition in the context of human health, chronic disease prevention, food security, and dietetics.

UNDERGRADUATE PROGRAMS

The department offers Bachelor of Science degree programs with majors in Dietetics, Food Science, and in Nutritional Sciences. Additional information describing career opportunities for each of these majors may be found in the sections below. Minors in Beverage Science and Technology, and in Food Processing and Technology are also available.

Students who are enrolled in the Bachelor of Science degree program with a major in food science may elect a Minor in Plant, Animal, and Microbial Biotechnology. For additional information, refer to the *Minor in Plant, Animal, and Microbial Biotechnology* statement.

DIETETICS

The undergraduate program in dietetics has been approved by the Academy of Nutrition and Dietetics' Accreditation Council for Education in Nutrition and Dietetics (ACEND) as a Didactic Program that meets the minimum academic requirements for professionally qualified dietitians.

The undergraduate program in dietetics is designed so that supporting disciplines provide a knowledge base prerequisite to the professional courses. Course offerings are sequenced to build upon previous knowledge and provide increasingly complex experiences. The student is expected to acquire approximately equal expertise in nutritional assessment and care and in foodservice management systems.

Verification of successful completion of the ACEND-approved minimum academic requirements is the responsibility of the Dietetics Program Director in the Department of Food Science and Human Nutrition.

Persons who wish to receive a final Verification Statement for the fulfillment of ACEND-approved minimum academic requirements from Michigan State University, but who have not completed a Bachelor of Science degree with a Dietetics major at Michigan State University, must complete a minimum of 10 credits in 300—400 level courses in dietetics at Michigan State University with a minimum grade of 2.0 or better in each course.

Eligibility for the registration examination for dietitians is determined by verification of successful completion of an ACEND-approved Didactic Program in Dietetics and one of the following supervised practice experiences: ACEND-approved Dietetic Internship, Coordinated Program, or Graduate Program. A master's degree is required to be eligible for the registration examination. Dietetic registration, as administered by the Commission on Dietetic Registration, is a requirement of most positions for professional dietitians. Licensure is an additional requirement for dietitians practicing in certain states.

Admission as a Junior

Enrollment in the dietetics major is limited. The Bachelor of Science Degree in Dietetics is a professional degree, which requires acceptance into a competitive internship in order to complete the requirements for eligibility to take the registered dietitian examination. A minimum cumulative grade-point average of 2.5 is necessary to be considered for admission.

Requirements for the Bachelor of Science Degree in Dietetics

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog.
   The University's Tier II writing requirement for the Dietetics major is met by completing Human Nutrition and Foods 411. That course is referenced in item 3. a. below.
   Students who are enrolled in the Dietetics major leading to the Bachelor of Science degree in the Department of Food Science and Human Nutrition may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biochemistry 200 or Physiology 250; Chemistry 141, 143, and 161. The completion of Chemistry 143 and 161 satisfies the laboratory requirement.
2. The requirements of the College of Agriculture and Natural Resources for Bachelor of Science and Bachelor of Arts degrees.
3. The following requirements for the major:

				CREDITS
a.	All of the following courses in the Department of Food Science and Human Nutrition (45 credits):			
	HNF	150	Introduction to Human Nutrition	3
	HNF	300	Experimental Approaches to Foods	4
	HNF	320	Professional Practice of Dietetics and Nutrition	3
	HNF	350	Advanced Human Nutrition and Metabolism	4
	HNF	377	Applied Community Nutrition	3
	HNF	378	Applied Nutrition Assessment Laboratory	1
	HNF	406	Global Foods and Culture	3
	HNF	411	Research Methods in Dietetics	3
	HNF	440	Foodservice Operations	3
	HNF	444	The Business of Nutrition Services	3
	HNF	445	Foodservice Management Practicum	2
	HNF	446	Applied Culinary Nutrition	2
	HNF	453	Nutrition and Human Development	3
	HNF	471	Medical Nutrition Therapy I	4
	HNF	472	Medical Nutrition Therapy II (W)	4
b.	The following courses outside the Department of Food Science and Human Nutrition (36 to 39 credits):			
	(1) All of the following courses (30 credits):			
	ANTR	350	Human Gross Anatomy for Pre-Health Professionals	3
	BMB	200	Introduction to Biochemistry	4
	CEM	141	General Chemistry	4
	CEM	143	Survey of Organic Chemistry	4
	CEM	161	Chemistry Laboratory I	1
	FSC	342	Food Safety and Hazard Analysis Critical Control Point Program	3
	MGT	325	Management Skills and Processes	3
	PSL	250	Introductory Physiology	4
	PSY	101	Introductory Psychology	4

(2)One of the following courses (3 or 5 credits):

MTH	103	College Algebra	3
MTH	116	College Algebra and Trigonometry	5

(3)One of the following courses (3 or 4 credits):

STT	200	Statistical Methods	3
STT	201	Statistical Methods	4

FOOD SCIENCE

Graduates with a Bachelor of Science degree in food science may be employed by food and allied industries, federal and state governments, and sectors throughout academia to work at the interface between the production and delivery of food. The program also prepares students for advanced study in graduate and professional schools. The required courses stress the principles of food safety and preservation and the application of scientific principles to control and enhance the flavor, color, texture, and nutritive value of foods.

In addition to the core program, students in food science must complete one of the following interdisciplinary concentrations that are designed to provide additional breadth and depth: basic food science, food business and industry, food packaging, or food technology. The major and concentrations are Approved by the Institute of Food Technologists Higher Education Review Board.

Basic Food Science. This concentration is designed for students with an interest in integrating in-depth study of basic sciences with the core of their food science education. Advanced courses in chemistry, microbiology, food safety, toxicology and pharmacology are among the fields students may elect to strengthen their bachelor's degree. Students interested in professional post-graduate education such as medicine and dentistry may elect to take a series of courses that meets the admission standards for most professional colleges.

Food Business and Industry. This concentration is designed for students who are interested in working for food or food-related businesses, where a knowledge of both food science and of food business management, economics, and marketing is important. Students who complete this concentration may pursue careers in manufacturing management, technical sales, food product marketing, or similar areas or may pursue graduate study in business.

Food Packaging. This concentration is designed to prepare students for careers in the food industry with an emphasis in food packaging. The concentration focuses on the design, use, and evaluation of food packaging materials and the effect of packaging materials on the shelf life of food. Students who complete this concentration may pursue graduate study in packaging or food science.

Food Technology. This concentration focuses on food processing methods and their effect on food quality and process characteristics. Students who complete this concentration may pursue careers in production supervision, quality assurance, inspection, product development, and process development. They may also pursue graduate study to prepare for positions in research, production, and management in the food industry, government, or universities.

Requirements for the Bachelor of Science Degree in Food 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 Food Science.

   The University's Tier II writing requirement for the Food Science major is met by completing all of the following courses: Food Science 402, 440, 441, 455, 470. Those courses are referenced in item 3.a. below.

   Students who are enrolled in the Food Science major leading to the Bachelor of Science degree in the Department of Food Science and Human Nutrition may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 161, Chemistry 161 and 162, and Physics 221, 231, 241 or Lyman Briggs 273. The completion of Chemistry 161 and 162 satisfies the laboratory requirement. Biological Science 161, Chemistry 161 and 162 and Physics 221, 231, 241 or Lyman Briggs 273 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of Mathematics 124 satisfies the College's mathematics requirement.
3. The following requirements for the major:

a. All of the following courses (51 credits):

			CREDITS
BE	429	Fundamentals of Food Engineering	3
BS	161	Cell and Molecular Biology	3
CEM	141	General Chemistry	4
CEM	142	General and Inorganic Chemistry	3
CEM	161	Chemistry Laboratory I	1
CEM	162	Chemistry Laboratory II	1
FSC	211	Principles of Food Science	3
FSC	222	Professional Development and Career Planning in Food Science	1
FSC	310	Sensory Analysis and Consumer Research	3
FSC	322	Advanced Professional Seminar in Food Science	1
FSC	325	Food Processing: Unit Operations	3
FSC	401	Food Chemistry	3
FSC	402	Food Chemistry Laboratory	1
FSC	440	Food Microbiology	3
FSC	441	Food Microbiology Laboratory	2
FSC	442	Hazard Analysis Critical Control Point Training and Certification	1
FSC	455	Food and Nutrition Laboratory	3
FSC	470	Integrated Approaches to Food Product Development	3
HNF	150	Introduction to Human Nutrition	3
MMG	301	Introductory Microbiology	3
MTH	124	Survey of Calculus I	3

b. One of the following courses (3 or 4 credits):

LB	273	Physics I	4
PHY	221	Studio Physics for Life Scientists I	4
PHY	231	Introductory Physics I	3
PHY	241	Physics for Cellular and Molecular Biologists I	4

c. One of the following courses (3 credits):

FSC	430	Food Processing: Fruits and Vegetables	3
FSC	431	Food Processing: Cereals	3

d. One of the following courses (3 credits):

FSC	432	Food Processing: Dairy Foods	3
FSC	433	Food Processing: Muscle Foods	3

e. Completion of a minimum of 3 credits in Experiential Learning. Students must consult with their academic advisor for specific details on this requirement. Completion of this requirement may be fulfilled by enrollment in FSC 475, FSC 493, FSC 499 or other approved experiences.

f. One of the following concentrations (23 to 26 credits):

Basic Food Science (25 credits):

(1)All of the following courses (16 credits):

BMB	401	Comprehensive Biochemistry	4
CEM	251	Organic Chemistry I	3
CEM	252	Organic Chemistry II	3

CEM 255 Organic Chemistry Laboratory 2
STT 201 Statistical Methods 4

(2)At least 9 credits from the following courses (9 credits):

ANS 407 Food and Animal Toxicology 3
CEM 262 Quantitative Analysis 3
CEM 333 Instrumental Methods and Applications 3
CEM 383 Introductory Physical Chemistry I 3
FSC 421 Food Laws and Regulations 3
LB 274 Physics II 4
MMG 409 Eukaryotic Cell Biology 3
MMG 425 Microbial Ecology 3
MMG 431 Microbial Genetics 3
MMG 445 Microbial Biotechnology (W) 3
MMG 451 Immunology 3
PHM 350 Introductory Human Pharmacology 3
PHM 450 Introduction to Chemical Toxicology 3
PHY 222 Studio Physics for Life Scientists II 4
PHY 232 Introductory Physics II 3
PHY 242 Physics for Cellular and Molecular Biologists II 4

Note: Only one physics courses (LB 274, PHY 222, PHY 232, PHY 242) can be counted towards the 9 credits.

The Basic Food Science concentration fills many, but not all, of the minimum requirements for admission to professional schools. Students interested in preparing for post-graduate professional programs should consult with a preprofessional advisor in the College of Natural Science. Admission requirements of professional schools vary and the student is responsible for reviewing the requirements of each school of interest and consulting regularly with an advisor.

Food Business and Industry (23 credits):

(1)All of the following courses (17 credits):

ACC 230 Survey of Accounting Concepts 3
BMB 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
MKT 327 Introduction to Marketing 3
STT 315 Introduction to Probability and Statistics for Business 3

(2)Two of the following courses (6 credits):

AFRE 100 Decision-making in the Agri-Food System 3
AFRE 222 Agribusiness and Food Industry Sales 3
AFRE 240 Food Product Marketing 3
AFRE 435 Financial Management in the Agri-Food System 3

Or

FI 320 Introduction to Finance 3
AFRE 440 Food Marketing Management 3
HB 265 Hospitality Food Service Systems I 3
HB 347 Hospitality Supply Chain Process 3
HB 358 Hospitality Entrepreneurship 3
HB 365 Hospitality Foodservice Systems II 3
HB 409 Introduction to Wine 3
HB 411 Hospitality Beverages 3
MKT 302 Consumer Behavior 3

Either FI 320 or AFRE 435, but not both of those courses, may be used to satisfy requirement (2) for the Food Business and Industry concentration.

Food Packaging (25 credits):

(1)All of the following courses:

BMB 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
PKG 101 Principles of Packaging 3
PKG 221 Packaging with Glass and Metal 2
PKG 322 Packaging with Paper and Paperboard 4
PKG 323 Packaging with Plastics 4
STT 201 Statistical Methods 4

Food Technology (23 credits):

(1)All of the following courses (14 credits):

BMB 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
FSC 420 Quality Assurance 2
STT 201 Statistical Methods 4

(2)At least 9 credits from the following courses (9 credits):

CEM 482 Science and Technology of Wine Production 3
CHE 483 Brewing and Distilled Beverage Technology 3
FSC 421 Food Laws and Regulations 3
FSC 430 Food Processing: Fruits and Vegetables 3
FSC 431 Food Processing: Cereals 3
FSC 432 Food Processing: Dairy Foods 3
FSC 433 Food Processing: Muscle Foods 3
FSC 481 Fermented Beverages 3
HB 100 Introduction to Hospitality Business 3
HB 265 Hospitality Foodservice Systems I 3
HB 347 Hospitality Supply Chain Process 3
HB 358 Hospitality Entrepreneurship 3
HB 365 Hospitality Foodservice Systems II 3
HB 409 Introduction to Wine 3
HB 411 Hospitality Beverages 3
HNF 300 Experimental Approaches to Food 4
HRT 403 Handling and Storage of Horticultural Crops 3
HRT 430 Exploring Wines and Vines 3

Courses selected to meet this requirement may not be used to fulfill requirement 3. b. or 3. c. above.

NUTRITIONAL SCIENCES

The nutritional sciences major emphasizes intensive study in biological and physical sciences as a basis for understanding the science of nutrition and the relationships between nutrients and human health. Core course requirements emphasize human nutrition with areas of study in energy metabolism, proteins, vitamins, minerals, and nutrition in the prevention and treatment of disease. Issues and techniques involved in nutrition research, and a food and nutrition laboratory course are included in the core courses. Supporting discipline courses emphasize biochemistry, biology, chemistry, mathematics, microbiology, physics and physiology.

This major offers the opportunity to concentrate in one of three areas. The biomedical nutrition concentration is designed to meet the admissions requirements of most colleges of medicine, dentistry and paramedical colleges while the student pursues a bachelor's degree in a clinically related area. The global nutrition and health concentration emphasizes the international aspects of nutrition within the context of sustainability, policy, food security, and agricultural systems. The public health nutrition concentration allows students to develop skills in biostatistics, epidemiology, and program planning and evaluation, in the context of nutrition and population health. The major also prepares students to enter graduate school programs in nutrition and other life sciences. Graduates in nutritional sciences qualify for positions in the food industry, corporate wellness and health promotion programs, public health programs, pharmaceutical sales and similar occupations.

Requirements for the Bachelor of Science Degree in Nutritional Sciences

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog.

   The University's Tier II writing requirement for the Nutritional Sciences major is met by completing Human Nutrition and Foods 450. This course is referenced in item 3. below.

   Students who are enrolled in the Nutritional Sciences major leading to the Bachelor of Science degree in the Department of Food Science and Human Nutrition may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Chemistry 141, 161; Biological Science 161 and 171. The completion of Chemistry 161 and Biological Science 171 satisfies the laboratory requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

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

   The completion of Mathematics 124 or 132 or Lyman Briggs 118 satisfies the college mathematics requirement.

3. The following requirements for the major:

CREDITS

a. The following courses (41 to 43):

(1) All of the following courses (25 credits):

COM	100	Human Communication	3
CSS	124	Introduction to Sustainable Agriculture and Food Systems	2
FSC	211	Principles of Food Science	3
FSC	455	Food and Nutrition Laboratory	3
HNF	150	Introduction to Human Nutrition	3
HNF	250	Contemporary Issues in Human Nutrition	3
HNF	255	Professional Development and Career Planning in Nutrition	1
HNF	350	Advanced Human Nutrition and Metabolism	4
HNF	450	Nutrition in the Prevention and Treatment of Disease	3

(2) One of the following, either (a) or (b) (5 credits):

(a)	BS	161	Cell and Molecular Biology	3
	BS	171	Cell and Molecular Biology Laboratory	2
(b)	LB	145	Biology II: Cellular and Molecular Biology	5

(3) One course from each of the following groups (a) and (b) (5 or 6 credits):

(a)	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
(b)	CEM	161	Chemistry Laboratory I	1
	CEM	185H	Honors Chemistry Laboratory I	2
	LB	171L	Introductory Chemistry Laboratory I	1

(4) One of the following courses (3 or 4 credits):

MTH	124	Survey of Calculus I	3
MTH	132	Calculus I	3
LB	118	Calculus I	4

(5) Completion of a minimum of 3 credits in Experiential Learning. Students must consult with their academic advisor for specific details on this requirement. Completion of this requirement may be fulfilled by enrollment in ANR 475, HNF 475, HNF 493, HNF 499 or any approved study abroad, service, or research experience.

b. One of the following concentrations:

Biomedical and Molecular Nutrition (40 to 52 credits):

(1) One of the following, either (a) or (b) (4 or 6 credits):

(a)	BMB	401	Comprehensive Biochemistry	4
(b)	BMB	461	Advanced Biochemistry I	3
	BMB	462	Advanced Biochemistry II	3

(2) One of the following, either (a), (b), (c), or (d) (8 to 10 credits):

(a)	LB	273	Physics I	4
	LB	274	Physics II	4
(b)	PHY	221	Studio Physics for Life Scientists I	4
	PHY	222	Studio Physics for Life Scientists II	4
(c)	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
(d)	PHY	241	Physics for Cellular and Molecular Biologists I	4
	PHY	242	Physics for Cellular and Molecular Biologists II	4
	PHY	251	Introductory Physics Laboratory I	1
	PHY	252	Introductory Physics Laboratory II	1

(3) All of the following courses (11 credits):

CEM	251	Organic Chemistry I	3
Or			
LB	271	Organic Chemistry	3
CEM	252	Organic Chemistry II	3
CEM	255	Organic Chemistry Laboratory	2
HNF	310	Nutrition in Medicine for Pre-Health Professionals	3

(4) One of the following courses (3 or 4 credits):

STT	201	Statistical Methods	4
STT	231	Statistics for Scientists	3

(5) One course from each of the following groups (4 or 5 credits):

(a)	CEM	142	General and Inorganic Chemistry	3
	CEM	152	Principles of Chemistry	3
	CEM	182H	Honors Chemistry II	4
	LB	172	Principles of Chemistry II	3
(b)	CEM	162	Chemistry Laboratory II	1
	LB	172L	Principles of Chemistry II – Reactivity Laboratory	1

(6) One of the following, either (a) or (b) (4 or 8 credits):

(a)	PSL	310	Physiology for Pre-Health Professionals	4
(b)	PSL	431	Human Physiology I	4
	PSL	432	Human Physiology II	4

(7) Two of the following courses (6 to 8 credits):

ANTR	350	Human Gross Anatomy for Pre-Health Professionals	3
CEM	262	Quantitative Analysis	3
IBIO	341	Fundamental Genetics	4
IBIO	450	Cancer Biology (W)	3
MMG	301	Introductory Microbiology	3
MMG	409	Eukaryotic Cell Biology	3
MMG	451	Immunology	3
PHL	344	Ethical Issues in Healthcare	4
PHM	350	Introductory Human Pharmacology	3
PSY	320	Health Psychology	3
PSY	333	The Neurobiology of Food Intake and Overeating	3

Global Nutrition and Health (43 to 49 credits):

(1) All of the following courses (17 credits):

HNF	377	Applied Community Nutrition	3
HNF	377L	Applied Nutrition Assessment Laboratory	1
HNF	406	Global Foods and Culture	3
HNF	415	Global Nutrition	3
HNF	453	Nutrition and Human Development	3
PSL	310	Physiology for Pre-Health Professionals	4

(2) One of the following, (a) or (b), (4 or 6 credits):

(a)	CEM	143	Survey of Organic Chemistry	4
(b)	CEM	251	Organic Chemistry I	3
	CEM	252	Organic Chemistry II	3

(3) One of the following courses (3 credits):

AL	200	Cultural Difference and Study Abroad	3
ANP	200	Navigating Another Culture	3

(4) One of the following courses (4 credits):

BMB	200	Introduction to Biochemistry	4
BMB	401	Comprehensive Biochemistry	4

(5) One of the following courses (3 credits):

CSUS	429	Program Evaluation for Community Sustainability	3
CSUS	433	Grant Writing and Fund Development	3

(6) One of the following courses (3 or 4 credits):

STT	201	Statistical Methods	4
STT	224	Introduction to Probability and Statistics for Ecologists	3
STT	231	Statistics for Scientists	3
STT	464	Statistics for Biologists	3

(7) One of the following courses (3 or 4 credits):

CSUS	215	International Development and Sustainability	3
MC	430	Applied International Development	4
SOC	161	International Development and Change	3
SOC	362	Developing Societies	3

(8) Two of the following courses (6 to 8 credits):

AFRE	260	World Food Population and Poverty	3
ANP	270	Women and Health: Anthropological and International Perspectives	3
ANP	370	Culture, Health, and Illness	3
CSS	431	International Agricultural Systems	3
CSUS	215	International Development and Sustainability	3
CSUS	463	Food Fight: Politics of Food	3
GEO	235	Geography of Environment and Health	3
GEO	435	Geography of Health and Disease	3
GLG	446	Ecosystems Modeling, Water and Food Security	3
GSAH	230	Values, Experience, and Difference in Global Contexts	3
HNF	475	International Studies in Human Nutrition	3
MC	337	Global Public Health	4
MC	430	Applied International Development	4
PHL	452	Ethics and Development	3
PHL	453	Ethical Issues in Global Public Health	3
SOC	161	International Development and Change	3
SOC	362	Developing Societies	3

A course used to fulfill requirement (7) in this concentration may not be used to fulfill this requirement. A course used to fulfill requirement 3. a. (5) may not be used to fulfill this requirement.

Public Health Nutrition (39 to 43 credits):

(1) All of the following courses (22 credits):

HM	101	Introduction to Public Health	3
HNF	377	Applied Community Nutrition	3
HNF	385	Public Health Nutrition	3
HNF	485	Advanced Public Health Nutrition	3
PSL	310	Physiology for Pre-Health Professionals	4
STT	421	Statistics I	3
STT	422	Statistics II	3

(2) One of the following, either (a) or (b), (4 or 6 credits):

(a)CEM	143	Survey of Organic Chemistry	4
(b)CEM	251	Organic Chemistry I	3
CEM	252	Organic Chemistry II	3

(3) One of the following courses (4 credits):

BMB	200	Introduction to Biochemistry	4
BMB	401	Comprehensive Biochemistry	4

(4) One of the following courses (3 credits):

CSUS	429	Program Evaluation for Community Sustainability	3
CSUS	433	Grant Writing and Fund Development	3

(5) Two of the following courses (6 to 8 credits):

ANP	270	Women and Health: Anthropological and International Perspectives	3
ANP	370	Culture, Health, and Illness	3
ANP	443	Human Adaptability	3
CSUS	463	Food Fight: Politics of Food	3
EPI	390	Disease in Society: Introduction to Epidemiology and Public Health	4
GEO	435	Geography of Health and Disease	3
HNF	453	Nutrition and Human Development	3
HNF	475	International Studies in Human Nutrition	3
MC	337	Global Public Health	4
PHL	453	Ethical Issues in Global Public Health	3
PLS	313	American Public Policy	3
SOC	451	Dynamics of Population	3
SOC	475	Health and Society	3

A course used to fulfill requirement 3. a. (5) may not be used to fulfill this requirement.

MINOR IN BEVERAGE SCIENCE AND TECHNOLOGY

The Minor in Beverage Science and Technology is designed to provide students with fundamental knowledge of the production of fermented beverages. Certain courses in this minor are only offered at off-campus wineries or breweries. The minor is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University. The minor is administered by the Department of Food Science and Human Nutrition.

With the approval of the department and college that administer the student's degree program, the courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Beverage Science and Technology

Students must complete 15 credits from the following:

			CREDITS
1. One of the following courses (3 credits):			
FSC	342	Food Safety and Hazard Analysis Critical Control Point Program	3
MMG	201	Fundamentals of Microbiology	3
MMG	301	Introductory Microbiology	3
2. One of the following courses (3 credits):			
BE	350	Heat and Mass Transfer in Biosystems	3
BE	429	Fundamentals of Food Engineering	3
CHE	311	Fluid Flow and Heat Transfer	3
FSC	325	Food Processing: Unit Operations	3
ME	410	Heat Transfer	3
3. All of the following courses (9 credits):			
CEM	482	Science and Technology of Wine Production	3
CHE	483	Brewing and Distilled Beverage Technology	3
FSC	481	Fermented Beverages	3

MINOR IN FOOD PROCESSING AND TECHNOLOGY

The Minor in Food Processing and Technology is available as an elective to students who are enrolled in bachelor's degree programs in the College of Agriculture and Natural Resources (other than the Bachelor of Science degree program with a major in food science), The School of Hospitality Business, and the Department of Microbiology, Genetics, and Immunology and to students who are enrolled in the Environmental Biology/Microbiology and Microbiology coordinate majors in Lyman Briggs College. The Department of Food Science and Human Nutrition administers the minor. The primary educational objective of the minor is to provide students with basic knowledge of food processing. The undergraduate coordinator for food science in the Department of Food Science and Human Nutrition is available to assist students in planning their programs of study for the minor.

With the approval of the college and department that administer the student's degree program, the courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Food Processing and Technology

The student must complete:

			CREDITS
1. One of the following courses (3 credits):			
ANS	201	Animal Products	3
FSC	211	Principles of Food Science	3
2. The following course (3 credits):			
FSC	325	Food Processing: Unit Operations	3
3. Two of the following courses (5 or 6 credits):			
FSC	342	Food Safety and Hazard Analysis Critical Control Point Program	3
FSC	420	Quality Assurance	2
FSC	421	Food Laws and Regulations	3
4. Two of the following courses (6 credits):			
CEM	482	Science and Technology of Wine Production	3
CHE	483	Brewing and Distilled Beverage Technology	3
FSC	430	Food Processing: Fruits and Vegetables	3
FSC	431	Food Processing: Cereals	3
FSC	432	Food Processing: Dairy Foods	3
FSC	433	Food Processing: Muscle Foods	3
FSC	481	Fermented Beverages	3

GRADUATE STUDY

The department offers Master of Science and Doctor of Philosophy degree programs with majors in food science, and a Master of Science with a major in nutrition and dietetics. Those programs are described below. The department also offers Master of Science and Doctor of Philosophy degree programs with majors in human nutrition. Those programs are also described below. In addition, the department offers programs for postdoctoral research.

Each graduate program in the Department of Food Science and Human and Nutrition is designed to prepare the student to become a specialist in food science or human nutrition. Programs of study and research are flexible and are designed to meet the needs and objectives of individual students. Emphasis is placed on a sound educational

program to develop a high degree of professional competence in a specific program area. Attendance and participation at seminars and participation in the teaching programs are designed to broaden the student's background for future careers.

Students who are enrolled in Master of Science degree programs in the Department of Food Science and Human Nutrition may elect a Specialization in Environmental Toxicology. For additional information, refer to the *Graduate Specialization in Environmental Toxicology* statement.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of Food Science and Human Nutrition may elect specializations in Infancy and Early Childhood. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Infancy and Early Childhood* in the *College of Social Science* section of this catalog.

FOOD SCIENCE

Master of Science

Admission

Admission to the Master of Science Degree in Food Science is based on the following:

1. A detailed review of undergraduate, and where applicable, previous graduate performance.
2. Letters of recommendation.
3. Previous research experience.
4. A letter of intent and research interests.

Applicants should have a minimum grade-point average of 3.0, grades of 3.0 or above in science and mathematics courses, and proficiency in written and spoken English. Applicants should have taken undergraduate course work in physics, inorganic chemistry, organic chemistry, biochemistry, mathematics through integral calculus, and microbiology. It also is desirable for students to have taken upper-level undergraduate course work in food processing, food chemistry, food microbiology, food engineering, and nutrition.

In cases where students entering the master's program with one or more deficiencies in undergraduate course work, appropriate collateral courses will be recommended by the Graduate Affairs Committee, Director of Graduate Studies, their advisor, and guidance committee. Credits earned in collateral courses do not count toward the minimum credit requirements for a degree.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students who are admitted to the master's degree program in food science must meet the requirements specified below.

Requirements for the Master of Science Degree in Food Science

The Master of Science Degree in Food Science is available under Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under Plan A or Plan B.

CREDITS

Students must:

1. Complete 16 credits at the 800-level or above. Two courses (6 credits) must be FSC courses excluding FSC 890, 892, 898, and 899.
2. Complete a minimum of 7 credits (Plan A) or 12 credits (Plan B) of focused course work in consultation with the major advisor and guidance committee.
3. Complete 1 credit of FSC 892 Food Science Seminar, in which students will present one seminar. Students may re-enroll in FSC 892 for a maximum of 2 credits towards the master's degree.

Additional Requirements for Plan A

1. Complete 6 credits in FSC 899 Master's Thesis Research. Students may not earn more than 10 credits in FSC 899.
2. Complete a thesis proposal approved by the guidance committee prior to initiation of research not related to the seminar given in FSC 892.
3. Successfully complete a written thesis, public oral thesis defense, and oral examination with the guidance committee.

Additional Requirements for Plan B

1. Complete 1 credit of FSC 898 Master's Research. Students may not earn more than 5 credits in FSC 898.
2. Complete an oral examination with the guidance committee.

Doctor of Philosophy

Admission

Admission to the Doctor of Philosophy Degree in Food Science is based on the following:

1. A detailed review of undergraduate, and where applicable, previous graduate performance.
2. Letters of recommendation.
3. Previous research experience.
4. A letter of intent and research interests.

Applicants should have a minimum grade-point average of 3.0, grades of 3.0 or above in science and mathematics courses, and proficiency in written and spoken English. Applicants should have taken undergraduate course work in physics, inorganic chemistry, organic chemistry, biochemistry, mathematics through integral calculus, and microbiology. It also is desirable for students to have taken upper-level undergraduate course work in food processing, food chemistry, food microbiology, food engineering, and nutrition.

In cases where students entering the doctoral program with one or more deficiencies in undergraduate course work, appropriate collateral courses will be recommended by the Graduate Affairs Committee, Director of Graduate Studies, their advisor, and guidance committee. Credits earned in collateral courses do not count toward the minimum credit requirements for a degree.

Doctoral programs in food science are individualized programs of study formulated among the major advisor, the research guidance committee, and the candidate. The program will be designed to ensure that the student will have comprehensive knowledge of the general field of food science, detailed knowledge of a specialized are in the field, and supportive knowledge of cognitive subjects.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students who are admitted to the doctoral degree program in food science must meet the requirements specified below.

Requirements for the Doctor of Philosophy Degree in Food Science

The Doctor of Philosophy Degree in Food Science typically requires 20 to 36 course credits in addition to 24 research credits of FSC 999 Doctoral Dissertation Research to provide the desired breadth and depth of academic training for the student. In consultation with their major advisor, members of the research guidance committee, and the Director of Graduate Studies, additional course work may be specified that will benefit the student's research as well as courses necessary to complete the Ph.D. core requirements, especially for students who have earned a master's degree in another field. A cumulative grade-point average of 3.0 must be maintained exclusive of collateral and research credits.

CREDITS

Students must:

1. Complete 16 credits, with 12 credits at the 800-level or above, excluding seminar courses. Three courses (9 credits) must be FSC courses in a relevant area of research chosen in consultation with the major advisor and guidance committee. Upper-level undergraduate courses at the 400-level taken may be counted if approved in advance by the advisor, guidance committee, and Director of Graduate Studies.
2. Complete 2 credits of FSC 892 Food Science Seminar in two separate enrollments, in which students will present a seminar.
3. Complete a 1 credit course offered by the department or university on writing a research proposal.
4. Complete at least 1 credit of FSC 891 Selected Topics in Food Science with a Food Science and Human Nutrition faculty member related to graduate teaching orientation.
5. Complete a written dissertation proposal defense (comprehensive examination) and public seminar not related to requirement 2. above, followed by an oral examination with the guidance committee.
6. Completion of a final written dissertation and public oral defense, followed by an oral examination with the guidance committee.
7. Complete 24 credits of FSC 999 Doctoral Dissertation Research.

HUMAN NUTRITION

Master of Science

The Master of Science degree in Human Nutrition includes research, course work in advanced nutrition, statistics, seminars, and appropriate selections from one or more of the following areas: biochemistry, physiology, anthropology, immunology, epidemiology, psychology, or sociology. Students in this program must meet the requirements of the university and of the College of Agriculture and Natural Resources.

Admission

To be considered for admission to the Master of Science degree program in Human Nutrition an applicant must:

1. have completed a bachelor's degree with courses in nutrition, including upper-level macro-and micronutrients, community or lifespan nutrition, general and organic chemistry, biology, physiology, biochemistry, and statistics;
2. be proficient in written and spoken English;
3. have a prior grade-point average of 3.0 or higher;
4. submit a personal letter of intent and letters of reference.

Collateral course work may be required to overcome deficiencies, but will not count towards the degree requirements.

Requirements for the Master of Science Degree in Human Nutrition

The program is available under either Plan A (with thesis) or Plan B (without thesis). The student must complete at 30 credits.

CREDITS

The student must complete:

1. All of the following courses (10 credits):
   - HNF 820 Advanced Biochemical Nutrition 3
   - HNF 821 Advanced Vitamins and Minerals 3
   - HNF 823 Research Methods in Human Nutrition 3
   - HNF 892 Nutrition Seminar 1
2. One of the following courses (3 credits):
   - HNF 840 Human Nutrition and Chronic Diseases 3
   - HNF 891 Topics in Human Nutrition 3
3. One of the following courses (1 or 3 credits):
   - HNF 824 Nutrition Policies and Programs 1
   - Alternative public health or community nutrition course approved by guidance committee 3
4. A 3-credit graduate-level statistics course chosen in consultation with advisor and guidance committee.
5. A minimum of 5 credits (Plan A) or 11 credits (Plan B) in course work in one or more focus areas selected in consultation with the student's guidance committee.

Additional Requirements for Plan A

1. The following course (6 credits):
   - HNF 899 Master's Thesis Research 6

   Students may not earn more than 10 credits in HNF 899.
2. Successfully complete a proposal defense and defend the oral and written thesis.

Additional Requirements for Plan B

1. The following course (1 to 5 credits):
   - HNF 898 Master's Project 1 to 5

   Students may not earn more than 5 credits in HNF 898.
2. Successfully pass a qualifying examination and complete a final examination or evaluation.

NUTRITION AND DIETETICS

Master of Science

The Master of Science Degree in Nutrition and Dietetics is a practice-based program designed for students who are concurrently completing the Dietetic Internship program at Michigan State University. The program includes a supervised practice component of the Dietetic Internship at arranged sites in Michigan and online course work in research methods, advanced clinical nutrition, statistics, and seminars. The program is accredited by the Accreditation Council for Education in Nutrition and Dietetics (ACEND). In addition to supervised practice planned to result in competencies enumerated by the accrediting council, the program provides students with opportunities to engage in evidence-based activities and further acquisition of professional skills. Upon completion of the program and conferral of the master's degree, students may sit for the Registration Examination for Dietitian Nutritionists.

In addition to meeting the requirements of the University as described in the Graduate Education section of this catalog, students must meet the requirements specified below.

Admission

The MSU Dietetic Internship participates in an online Dietetic Internship Centralized Application System (DICAS). An admissions committee of MSU faculty and preceptors reviews applications and prepares a ranked list of approved applicants which is also reviewed by the FSHN Graduate Affairs Committee to ensure accepted applicants meet graduate school admissions criteria. An independent matching process is used to fill slots in internships nationwide based on the priority rankings of both applicants and internships.

To be considered for admission to the Master of Science degree in Nutrition and Dietetics, an applicant must:

1. have a Verification Statement from an ACEND-accredited Didactic Program in Dietetics (DPD);
2. complete a dietetic internship application through the Dietetic Internship Central Application Service (DICAS), which includes a personal statement, resume, three letters of reference, and transcripts from all colleges and universities attended;
3. have a prior DPD and overall grade point average of 3.0 or higher;
4. complete the MSU application for graduate studies.

Requirements for the Master of Science Degree in Nutrition and Dietetics

The program is available under Plan B (without thesis). The student must complete a total of 30 credits distributed as follows:

		CREDITS
1. All of the following courses (18 credits):		
HNF 823	Research Methods in Human Nutrition	3
HNF 832	Advanced Clinical Nutrition	3
HNF 892	Nutrition Seminar	2
HNF 894	Human Nutrition Practicum	6
HNF 898	Master's Project	1
NUR 804	Statistics for the Healthcare Professional	3
2. A minimum of 12 credits in one or more focus areas selected in consultation with the student's faculty advisor.		
3. Completion of a final project/case study and evaluation, including a formal presentation by the student on a topic approved by the internship director and faculty advisor through enrollment in HNF 898.		

Doctor of Philosophy

The Doctor of Philosophy degree in Human Nutrition is designed to prepare graduates for advanced careers that require demonstrated research skills, comprehensive knowledge of the discipline, and skills essential to the dissemination of that knowledge. Through their research and course work in advanced nutrition and related areas, the student will plan, conduct, manage, and publish independent, original research via the dissertation and peer-reviewed manuscripts. Students in the program must meet the requirements of the university and of the College of Agriculture and Natural Resources.

Admission

To be considered for admission to the Doctor of Philosophy degree program in Human Nutrition an applicant must:

1. have completed a bachelor's degree or master's degree with courses in nutrition, including upper-level macro- and micronutrients, community or lifespan nutrition, general and organic chemistry, biology, physiology, biochemistry, and statistics;
2. be proficient in written and spoken English;
3. have a prior grade-point average of 3.0 or higher;
4. submit a personal letter of intent, research experience, and letters of reference.

Collateral course work may be required to overcome deficiencies, but will not count towards the degree requirements.

Requirements for the Doctor of Philosophy Degree in Human Nutrition

		CREDITS
The student must:		
1. Complete all of the following courses (11 credits):		
HNF 820	Advanced Biochemical Nutrition	3
HNF 821	Advanced Vitamins and Minerals	3
HNF 823	Research Methods in Human Nutrition	3
HNF 892	Nutrition Seminar	2
2. One of the following courses (3 credits):		
HNF 840	Human Nutrition and Chronic Diseases	3
HNF 891	Topics in Human Nutrition	3
3. One of the following courses (1 or 3 credits):		
HNF 824	Nutrition Policies and Programs	1
	Alternative public health or community nutrition course approved by guidance committee	3
4. A 3-credit graduate-level statistics course chosen in consultation with advisor and guidance committee.		
5. Complete a mentored teaching experience through one the following courses (1 or 2 credits):		
HNF 894	Human Nutrition Practicum	1
ISE 870	Teaching College Science	2
6. Complete additional course work approved selected in consultation with the student's guidance committee based on the student's prior academic background in relation to the selected area of study and research.		
7. Complete 24 credits of course work in HNF 999 Doctoral Dissertation Research.		
8. Successfully complete a proposal defense and defend the oral and written dissertation.		

DEPARTMENT of FORESTRY

Richard K. Kobe, Chairperson

Forestry students discover their central role in sustaining forests and the ecosystem services that forests provide, including conservation of biodiversity, wood, clean water, and global climate stabilization. MSU forestry students learn to be leaders through multi-disciplinary course work, field studies, cutting-edge technology and mentorship from faculty.

The Bachelor of Science degree program in Forestry educates forestry science professionals. It integrates ecology, biology, economics and social science to help students solve some of the world's most pressing natural resource, environmental and energy issues. Students have the opportunity to minor in Sustainable Bioproducts Science and Technology or Urban and Community Forestry.

Our graduate programs include a research-intensive or a professional track for individuals pursuing a wide range of

careers in academia, management, public agencies, non-government organizations or the private sector. Students also have the option to obtain a Graduate Certificate in Spatial Ecology or in Forest Carbon Science, Policy and Management.

UNDERGRADUATE PROGRAMS

Undergraduates study Forestry as a global, interdisciplinary science. Students learn about forest ecosystems and the myriad of services they provide, as well as how to resolve forest-centered environmental and natural resource issues. Students develop the knowledge and tools needed to restore and enhance the capacity of forests to sustain health and prosperity of humans and other organisms.

The Bachelor of Science degree in Forestry emphasizes innovation and is the longest-standing and among the leading programs in the United States. The Bachelor of Science degree is accredited by the Society of American Foresters. The Department of Forestry maintains strong connections to an accomplished alumni base to provide current students with opportunities for internships and employment in Michigan and throughout the world.

FORESTRY

"How can forest ecosystems and all their recognized values be sustained in the modern world?" This is a fundamental question for the 21st century, as forest ecosystems are facing grave threats all over the world, including large-scale deforestation, forest degradation, invasive pests and pathogens, and global climate change. In the face of these threats, forestry professionals have a great responsibility and opportunity to maintain, restore and enhance the sustainability of forest ecosystems.

Students enrolled in the Bachelor of Science Degree in Forestry program develop an in-depth understanding of the natural and social sciences in order to manage forest ecosystems. The Bachelor of Science degree is accredited by the Society of American Foresters. Through hands-on laboratory experiences and field studies, students learn how to manage forests for a wide range of goals and acquire the skills to evaluate and ensure the ecological, economic, and social sustainability of forests. They place emphasis on development of analytical and communications skills necessary to create a positive exchange of ideas between forestry professionals and non-technical audiences. Students who graduate from this program will possess the professional training to enable them to contribute significantly to resolution of forest-centered environmental and resource problems.

Forest professionals are employed in a variety of settings. Many choose careers with public land management agencies, such as the United States Department of Agriculture Forest Service, the National Park Service, the Fish and Wildlife Service, the Soil Conservation Service, or state departments of natural resources. Conservation organizations, such as the Wilderness Society and the Nature Conservancy, also hire forestry professionals. Forestry professionals are in high demand in the forest products industry, including in sustainable production of environmentally responsible wood products and management of bio-energy plantations. Increasingly, forestry expertise is required to combat climate change through work on forest-based climate mitigation projects, in both domestic and international settings.

Requirements for the Bachelor of Science Degree in Forestry

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 Forestry.

   The University's Tier II writing requirement for the Forestry major is met by completing Forestry 330, 340L, 406L, 414, and 468. Those courses are referenced in item 3. a. below.

   Students who are enrolled in the Forestry major leading to the Bachelor of Science degree in the Department of Forestry may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Plant Biology 105 and 106 combined; and Chemistry 141 and 161.

   The completion of Chemistry 161 and Plant Biology 106 satisfies the laboratory requirement. Plant Biology 105 and 106 combined, and Chemistry 141 and 161 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of Mathematics 124 or 132 satisfies the College's mathematics requirement.
3. The following requirements for the major:

			CREDITS
a.	All of the following courses (68 credits):		
	CEM 141	General Chemistry	4
	CEM 161	Chemistry Laboratory I	1
	CSS 210	Fundamentals of Soil Science	3
	EC 201	Introduction to Microeconomics	3
	FOR 110	Contemporary Issues in Forests and the Environment	1
	FOR 128	Practical Computing and Data Science Tools	3
	FOR 204	Forest Vegetation	3
	FOR 215	Introduction to Wildland Fire	2
	FOR 222	Forestry Field Methods	3
	FOR 330	Human Dimensions of Forests	3
	FOR 340	Forest Ecology	3
	FOR 340L	Forest Ecology Laboratory	2
	FOR 372	Ecological Monitoring and Data Analysis	3
	FOR 406	Applied Forest Ecology: Silviculture	3
	FOR 406L	Applied Forest Ecology: Silviculture Laboratory	1
	FOR 413	Wildland Fire Ecology and Management	3
	FOR 414	Renewable Wood Products	3
	FOR 419	Applications of Geographic Information Systems to Natural Resources Management	4
	FOR 420	Forestry Field Studies	3
	FOR 438	Forest Resource Economics	3
	FOR 466	Natural Resource Policy	3
	FOR 468	Forest Management Planning	3
	PLB 105	Plant Biology	3
	PLB 106	Plant Biology Laboratory	1
	PLP 407	Diseases and Insects of Forest and Shade Trees	4
b.	One of the following courses (3 credits):		
	MTH 124	Survey of Calculus I	3
	MTH 132	Calculus I	3
c.	One of the following courses (3 or 4 credits):		
	STT 201	Statistical Methods	4
	STT 224	Introduction to Probability and Statistics for Ecologists	3
	STT 231	Statistics for Scientists	3
	STT 421	Statistics I	3
d.	One of the following courses (3 credits):		
	FW 410	Upland Ecology and Management	3
	FW 417	Wetland Ecology and Management	3
	FW 444	Conservation Biology	3
	PLB 443	Restoration Ecology	3

e. One of the following courses (3 credits):

CSUS 433	Grant Writing and Fund Development	3
WRA 320	Technical Communication (W)	3
WRA 331	Writing in the Public Interest (W)	3
WRA 453	Grant and Proposal Writing	3

f. One of the following courses (1 to 3 credits):

FOR 490	Independent Study in Forestry	1 to 3
FOR 493	Professional Internship in Forestry	1 to 3
	An approved study abroad experience	1 to 3

MINOR IN FORESTRY

The Minor in Forestry is designed to serve students in other fields who desire additional training related to understanding of the nature of trees and forests and social-biological aspects of managing forest ecosystems. The minor is available to students who are enrolled in bachelor's degree programs at Michigan State University other than the Bachelor of Science Degree in Forestry.

With the approval of the department and college that administer the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree. Students who are interested in enrolling should contact an undergraduate advisor in the Department of Forestry.

Requirements for the Minor in Forestry

Students must complete the following requirements (18 or 19 credits):

		CREDITS
1. All of the following courses (9 credits):		
FOR 204	Forest Vegetation	3
FOR 222	Forestry Field Methods	3
FOR 330	Human Dimensions of Forests	3
2. One of the following courses (3 credits):		
FOR 101	Michigan's Forests	3
FOR 202	Introduction to Forestry	3
3. One of the following courses covering social aspects of Forestry (3 credits):		
FOR 414	Renewable Wood Products	3
FOR 438	Forest Resource Economics	3
FOR 466	Natural Resource Policy	3
4. One of the following courses covering biological aspects of Forestry (3 or 4 credits):		
FOR 340	Forest Ecology	3
	And	
FOR 340L	Forest Ecology Laboratory	1
FOR 406	Applied Forest Ecology: Silviculture	3
	And	
FOR 406L	Applied Forest Ecology: Silviculture Laboratory	1
FOR 413	Wildland Fire Ecology and Management	3
PLP 407	Diseases and Insects of Forest and Shade Trees	4

MINOR IN SUSTAINABLE BIOPRODUCTS SCIENCE AND TECHNOLOGY

The Minor in Sustainable Bioproducts Science and Technology, which is administered by the Department of Forestry, is designed to prepare students to pursue a career, or graduate degrees in renewable wood-based bioproducts. Upon graduation, students will be academically and professionally well positioned in acquiring employment in companies or government departments whose focus is green building construction and furnishings, bioproducts engineering, structural design, and other green bioproducts employment opportunities. Students will be prepared for graduate studies in biomaterials and bioproducts.

The minor is available as an elective to students enrolled in bachelor's degree programs at Michigan State University. 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.

Students who plan to apply to the program should consult the undergraduate advisor in the Department of Forestry.

Requirements for the Minor in Sustainable Bioproducts Science and Technology

Complete 19 to 21 credits from the following:

		CREDITS
1. Both of the following courses (6 credits):		
FOR 414	Renewable Wood Products	3
FOR 479	Wood and Engineered Composites Science and Technologies	3
2. One of the following courses (3 credits):		
CHE 468	Biomass Conversion Engineering	3
FOR 212	Introduction to Sustainable Bioproducts	3
	Biosystems Engineering and Chemical Engineering students must take CHE 468 and BE 469.	
3. One of the following courses (3 credits):		
BE 332	Engineering Properties of Biological Materials	3
CMP 222	Statics and Strengths of Materials	3
FOR 427	Biomass and Bioproducts Chemistry	3
MSE 320	Mechanical Properties of Materials	3
4. One of the following courses (3 credits):		
CMP 322	Structural Systems	3
CMP 491	Special Topics in Construction Management	3
MSE 426	Introduction to Composite Materials	3
MSE 465	Design and Application of Engineering Materials	3
	Students choosing CMP 491 must enroll in the section on Green and Energy Efficient Residential Constructions.	
5. One of the following courses (3 credits):		
BE 469	Sustainable Bioenergy Systems	3
FOR 335	Socioeconomics of Sustainable Bioproducts	3
	Biosystems Engineering and Chemical Engineering students must take CHE 468 and BE 469.	
6. One of the following professional internships (1 to 3 credits):		
CMP 493	Professional Internship in Construction Management	3
EGR 393	Engineering Cooperative Education	1
FOR 493	Professional Internship in Forestry	1 to 3
	The internship requirement can also be met by completing the internship course in the student's major department, but must be geared towards biomaterials and bioproducts and the course content and overall plan must be approved by the advisor for the minor in the Department of Forestry. The internship requirement can be met at any time during the student's academic program.	

MINOR IN URBAN AND COMMUNITY FORESTRY

The Minor in Urban and Community Forestry is designed to provide students with an understanding of the social, biological, and administrative aspects of managing urban and community forests. The minor serves students interested in careers with public agencies, the private sector, and non-profit organizations. The minor is administered by the Department of Forestry and is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University.

With the approval of the department and college that administer the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree. Students who are interested in enrolling should contact an undergraduate advisor in the Department of Forestry.

Requirements for the Minor in Urban and Community Forestry

		CREDITS
Students must complete the following (21 to 23 credits):		
1. All of the following courses (9 credits):		
FOR 222	Forestry Field Methods	3
FOR 461	Urban and Community Forestry	3
HRT 213	Landscape Maintenance	2
HRT 213L	Landscape Maintenance Field Laboratory	1
2. One of the following courses covering social aspects of urban and community forestry (3 credits):		
CSUS301	Community Engagement for Sustainability (W)	3
FOR 330	Human Dimensions of Forests	3
SOC 361	Contemporary Communities	3
SOC 375	Urban Sociology	3
3. One of the following courses covering biological aspects of urban and community forestry (3 credits):		
FOR 204	Forest Vegetation	3
HRT 211	Landscape Plants I	3
HRT 212	Landscape Plants II	3
4. One of the following courses (3 or 4 credits):		
FOR 340	Forest Ecology	3
HRT 361	Applied Plant Physiology	3
PLP 407	Diseases and Insects of Forest and Shade Trees	4
5. One of the following courses covering administrative aspects of urban and community forestry (3 or 4 credits):		
CSUS433	Grant Writing and Fund Development	3
PLS 310	Public Administration and Policy Making	3
UP 201	Introduction to Urban and Regional Planning	4
WRA 453	Grant and Proposal Writing	3

GRADUATE STUDY

The Department of Forestry offers Master of Science and Doctor of Philosophy degree programs in forestry, and plant breeding, genetics and biotechnology—forestry. The department also offers a Graduate Certificate in Forest Carbon Science, Policy and Management, and a Graduate Certificate in Spatial Ecology.

Students in the Master of Science degree program in forestry are eligible for the dual Juris Doctor (JD) program with Michigan State University - College of Law.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of Forestry may elect specializations in resource economics. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Resource Economics*.

Students enrolled in the Master of Science degree in Forestry may elect a specialization in Ecology, Evolution, and Behavior. Those enrolled in the Doctor of Philosophy degree in Forestry are eligible to pursue dual major degrees in Environmental Science and Policy and/or Ecology, Evolution, and Behavior.

FORESTRY

Master of Science

The Master of Science degree in Forestry is designed for individuals pursuing a wide range of careers in academia, public agencies, non-government organizations, or the private sector. The master's degree is available in two plans: research-intensive (Plan A) or professional (Plan B), with in-person and hybrid-online options for Plan B. The hybrid-online option is a professional degree oriented towards individuals with a bachelor's degree in a field other than forestry who would like to pursue a career in forestry. The program is uniquely tailored to learners that need flexibility, with the majority of the courses delivered in an online format to accommodate students with existing personal and professional commitments. While the requirements for the hybrid-online option are the same as the in-person option, it follows a prescribed set of courses (see *https://www.canr.msu.edu/for/graduate/Hybrid-Online-MS-Degree/hybrid-online-ms-requirements*).

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Requirements for the Master of Science Degree in Forestry

The master's degree program in forestry is available under either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under Plan A or Plan B. The student's program of study must be approved by either their major professor or guidance committee.

CREDITS

Requirements for Plan A

1. Complete the following course (2 credits):
   FOR 802 Forest Science Research 2
2. Complete a program of study approved by the major professor and guidance committee to meet the student's educational and career goals.
3. Complete at least 6 credits and no more than 10 credits in FOR 899 Master's Thesis Research.
4. Pass an oral examination, including a public presentation, in defense of the thesis, administered by the student's guidance committee. One re-examination may be scheduled at the discretion of the guidance committee. The final oral examination must be passed within five calendar years from the date of enrollment in the first course included for degree certification.

Requirements for Plan B

1. Complete a program of study approved by the major professor and guidance committee to meet the student's educational and career goals.
2. Complete a non-thesis capstone project, practicum or other professional development experience of at least 1 credit and no more than 6 credits through enrollment in FOR 898 Master's Professional Project. Upon completion of the project, a report must be completed and submitted to the student's guidance committee.
3. Pass a final oral examination, including a public presentation, in defense of the professional project, administered by the student's guidance committee. One re-examination may be scheduled at the discretion of the guidance committee. The final oral examination must be passed within five calendar years from the date of enrollment in the first course included for degree certification.

Doctor of Philosophy

The Doctor of Philosophy degree in Forestry provides advanced education to prepare future scholars and leaders who advance knowledge about forested ecosystems and help resolve issues that challenge the provision of forest ecosystem services at local, regional and global scales. The program is research-intensive and students will produce original applied or fundamental research of quality comparable to a two to four peer-reviewed publications in a scientific journal.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Requirements for the Doctor of Philosophy Degree in Forestry

	CREDITS
1. Complete the following course (2 credits):	
FOR 802 Forest Science Research	2
2. Complete a program of study approved by the major professor and guidance committee to meet the student's educational and career goals.	
3. Complete at least 24 credits and no more than 36 credits in FOR 999 Doctoral Dissertation Research.	
4. No more than 1/4th of the program of study can be from transfer credits. Graduate credits may be transferred from other postsecondary accredited institutions of comparable academic quality if they are appropriate to a student's program and were completed within the time limits approved for the earning of the degree at MSU.	
5. Comprehensive examinations must be completed within five years from the time when a student begins the first class at MSU that appears on the student's doctoral program of study.	
6. Successfully pass the final oral examination in defense of the dissertation.	

PLANT BREEDING, GENETICS and BIOTECHNOLOGY—FORESTRY

The Department of Forestry offers Master of Science and Doctor of Philosophy degree programs in plant breeding, genetics and biotechnology–forestry. Students meet the requirements for admission and the requirements for the degree as specified in the statement on Interdepartmental Graduate Programs in Plant Breeding, Genetics and Biotechnology.

Additional information about graduate study may be obtained by writing to the Department of Forestry.

GRADUATE CERTIFICATE IN FOREST CARBON SCIENCE, POLICY AND MANAGEMENT

The Graduate Certificate in Forest Carbon Science, Policy and Management provides students with interdisciplinary training necessary to plan, manage, monitor and evaluate climate change mitigation projects that seek to retain or sequester carbon in forest ecosystems. Students will gain specific expertise needed internationally to participate in market-based, climate change mitigation activities such as the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (REDD+). The graduate certificate is available online only.

Admission

To be considered for admission into the Graduate Certificate in Forest Carbon Science, Policy and Management, applicants must have completed a bachelor's degree in forestry, natural resources, environmental sciences, or a related field. For additional information, refer to the *Admission* section in the *Graduate Education* section of this catalog.

Requirements for the Graduate Certificate in Forest Carbon Science, Policy and Management

	CREDITS
Students must complete all of the following courses (9 credits):	
FOR 833 Human Dimensions of Forest Carbon Management	3
FOR 835 Forest Carbon Policy, Economics and Finance	3
FOR 837 Measurement and Monitoring of Forest Carbon	3

GRADUATE CERTIFICATE IN SPATIAL ECOLOGY

The Graduate Certificate in Spatial Ecology provides interdisciplinary training necessary to develop inference about ecological phenomena using appropriate spatial theory, statistics, modeling approaches, and data management tools. Students gain the necessary skills to address tomorrow's complex ecological challenges. The graduate certificate is available as an elective to students who are enrolled in master's or doctoral degree programs at Michigan State University.

For more information including how to apply, see *https://www.canr.msu.edu/spatial-ecology/*.

Requirements for the Graduate Certificate in Spatial Ecology

	CREDITS
1. The following course (4 credits):	
GEO 866 Spatial Data	4
2. One of the following courses (3 credits):	
FOR 870 Spatial Ecology	3
FW 840 Landscape Ecology	3
3. One of the following courses (3 or 4 credits):	
CSS 921 Geostatistics	3
FOR 867 Hierarchical Modeling and Computing for Spatio-temporal Environmental Data	3
FOR 870 Spatial Ecology	3
FW 840 Landscape Ecology	3
GEO 865 Advanced Quantitative Methods in Geography	4
GEO 869 Geosimulation	3
Forestry 870 and Fisheries and Wildlife 840 may not be used to fulfill this requirement if used to fulfill requirement 2. above.	

DEPARTMENT of HORTICULTURE

William Vance Baird, Chairperson

The Department of Horticulture at Michigan State was established in 1883 as the first horticulture department in a college or university in the United States – and we remain a leader in the field and the industry to this day. Horticulture is a complex and diversified, yet fully integrated discipline encompassing the biological, molecular and physical sciences, as well as business management, marketing and the arts. Horticulturists work to improve the sustainable production of nutritious, and safe food, advance the development and use of new specialty food and ornamental crops, enhance human health and well-being, and positively impact the natural and built environments. As such, horticultural crops (fruits, vegetables, and landscape ornamentals) and their utilization establish the important connection between applied and fundamental plant scientists, growers, consumers, society and the environment.

For students seeking a bachelor's degree, we offer three concentrations: Horticultural Science; Sustainable and Organic Horticulture; and Landscape Design, Construction and Management. This degree offers engagement in the full spectrum of professional horticulture across many disciplines and specialty crops. Additionally, multiple short-term

certificate programs are offered both on-campus, as well as around the state in partnership with community colleges, and provide a fast track for students wanting to enter the workforce of the landscape, nursery, greenhouse, fruit, vegetable, and organic horticulture industries. Our programs require a professional internship experience with an industry or academic employer, typically during the summer months. Our curriculum integrates theoretical, practical and hands-on experiences to help students develop problem-solving skills in science, technology, production, design and management.

Students are involved in professional and social activities beyond the classroom and design studio: gaining experience in research laboratories; assisting in field-based projects; managing the Student Horticulture Association spring show and plant sale; and training to participate in academic and field events associated with the National Collegiate Landscape Competition held annually at peer institutions around the U.S.

Our facilities include classroom and laboratories housed in the Plant and Soil Sciences Building, the nationally recognized Horticultural Demonstration Gardens, 4-H Children's Gardens, the Clarence E. Lewis Arboretum, and the Horticulture Teaching and Research Center (HTRC). The MSU Student Organic Farm is located at the HTRC where students gain practical, non-credit experiences and help produce food for a Community Supported Agriculture program as well as MSU's residential housing service.

UNDERGRADUATE PROGRAM

Horticultural foods and food products, flowers and landscapes sustain and enrich our lives. Horticulture is the science and art concerned with the breeding, culture, production, marketing, and utilization of high–value intensively cultivated plants. Horticultural crops are diverse, including annual and perennial species, food, medicinal and ornamental crops, and plants grown outdoors and in controlled environments. The primary horticulture discipline areas include pomology (fruits), olericulture (vegetables), floriculture (ornamentals) and landscape horticulture. Graduates with a major in horticulture enter a broad range of challenging and rewarding professional careers in production, management, marketing, education, consulting and service industries, including research in basic and applied plant science. In addition, graduates frequently become entrepreneurs or obtain employment in horticultural business enterprises (e.g., commercial production operations, landscape design/build and maintenance companies, nurseries, retail flower shops, or fruit and vegetable markets). Graduates may also pursue careers in nontraditional areas that require a knowledge of horticulture such as secondary education, the publication industry, or international development.

The study of horticulture at MSU is highly integrative, combining scientific and technical knowledge, and problem–solving skills for application in various professions related to horticulture. Students in horticulture combine diverse fundamental disciplines in physical science (chemistry), biological sciences (botany, genetics, physiology, entomology, and plant pathology), environmental science (soil science), with horticultural crop production, and business acumen (economics, management, and marketing). Communication and computer skills are also cultivated within the horticulture curriculum. Students complete one of three concentrations: Horticultural Science, Sustainable and Organic Horticulture, or Landscape Design, Construction, and Management. In all concentrations, students obtain hands–on experiences through exercises in the greenhouses, research laboratories, the horticulture gardens, or at the farms. Field trips expose students to successful horticultural businesses, industries, and support services within Michigan. Students gain professional work experience through internships, independent study, and part–time employment in research and extension programs within the Department of Horticulture.

Requirements for the Bachelor of Science Degree in Horticulture

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 Horticulture.

   The University's Tier II writing requirement for the Horticulture major is met by completing Horticulture 404. That course is referenced in item 3. a. below.

   Students who are enrolled in the Horticulture major leading to the Bachelor of Science degree in the Department of Horticulture may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Plant Biology 105 and 106 and Chemistry 141, 143, and 161. The completion of Plant Biology 106 and Chemistry 161 satisfies the laboratory requirement. Plant Biology 105 and 106 and Chemistry 141, 143, and 161 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of Mathematics 116 or its equivalent in fulfillment of the College of Agriculture and Natural Resources mathematics requirement which also may satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:

		CREDITS
a. All of the following courses (39 credits):		
CEM 141	General Chemistry	4
CEM 143	Survey of Organic Chemistry	4
CEM 161	Chemistry Laboratory I	1
CSS 210	Fundamentals of Soil Science	3
CSS 350	Introduction to Plant Genetics	3
HRT 203	Introduction to Horticulture	3
HRT 204	Plant Propagation and Use	3
HRT 207	Horticulture Career Development	1
HRT 361	Applied Plant Physiology	3
HRT 404	Horticulture Management (W)	3
HRT 493	Professional Internship in Horticulture	3
HRT 494	Horticulture Career Development II	1
PLB 105	Plant Biology	3
PLB 106	Plant Biology Laboratory	1
STT 200	Statistical Methods	3
b. One of the following concentrations (29 to 34 credits):		
Horticultural Science (29 credits):		
(1) Both of the following courses (8 credits):		
ENT 404	Fundamentals of Entomology	4
PLP 405	Plant Pathology	4
(2) Complete 12 credits from the following:		
CSS 226L	Weed Science Laboratory	1
CSS 326	Weed Science	2
HRT 211	Landscape Plants I	3
HRT 212	Landscape Plants II	3
HRT 218	Irrigation Systems for Horticulture	2
HRT 218L	Irrigation Systems for Horticulture Laboratory	1

	HRT	242	Passive Solar Greenhouses for Protected Cultivation 1
	HRT	243	Organic Transplant Production 1
	HRT	253	Compost Production and Use 1
	HRT	310	Nursery Management 3
	HRT	323	Floriculture Production: Herbaceous Perennials and Annuals 3
	HRT	332	Tree Fruit Production and Management 3
	HRT	336	Viticulture and Berry Production 2
	HRT	351	Hydroponic Food Production 2
	HRT	351L	Hydroponic Food Production Lab 2
	HRT	341	Vegetable Production and Management 3
	HRT	475	International Studies in Horticulture 3
(3)	Three of the following courses (9 credits):		
	CSS	442	Biotechnology and Plant Breeding 3
	CSS	451	Biotechnology Applications for Plant Breeding and Genetics 3
	HRT	401	Advanced Horticultural Crop Physiology 3
	HRT	403	Handling and Storage of Horticultural Crops 3
	HRT	407	Horticulture Marketing 3
	HRT	486	Biotechnology in Agriculture: Applications and Ethical Issues 3

Sustainable and Organic Horticulture (32 credits):

(1)	All of the following courses (14 credits):		
	CSS	360	Soil Biology 3
	ENT	479	Organic Pest Management (W) 3
	HRT	251	Organic Farming Principles and Practices 3
	HRT	253	Compost Production and Use 1
	PLP	405	Plant Pathology 4
(2)	Complete 9 credits from the following:		
	CSS	226L	Weed Science Laboratory 1
	CSS	326	Weed Science 2
	HRT	218	Irrigation Systems for Horticulture 2
	HRT	218L	Irrigation Systems for Horticulture Laboratory 1
	HRT	242	Passive Solar Greenhouses for Protected Cultivation 1
	HRT	243	Organic Transplant Production 1
	HRT	332	Tree Fruit Production and Management 3
	HRT	336	Viticulture and Berry Production 2
	HRT	341	Vegetable Production and Management 3
	HRT	351	Hydroponic Food Production 2
	HRT	351L	Hydroponic Food Production Lab 2
	HRT	475	International Studies in Horticulture 3
	HRT	490	Independent Study 1 or 2
(3)	Three of the following courses (9 credits):		
	CSUS	343	Community Food and Agricultural Systems 3
	HRT	401	Advanced Horticultural Crop Physiology 3
	HRT	403	Handling and Storage of Horticultural Crops 3
	HRT	407	Horticulture Marketing 3
	HRT	486	Biotechnology in Agriculture: Applications and Ethical Issues 3

Horticulture Landscape Design, Construction, and Management (34 credits):

(1)	All of the following courses (25 credits):		
	CSS	202	World of Turf 2
	HRT	211	Landscape Plants I 3
	HRT	212	Landscape Plants II 3
	HRT	213	Landscape Maintenance 2
	HRT	213L	Landscape Maintenance Field Laboratory 1
	HRT	218	Irrigation Systems for Horticulture 2
	HRT	218L	Irrigation Systems for Horticulture Laboratory 1
	HRT	311	Landscape Design and Management Specifications 4
	HRT	411	Landscape Contract Management 3
	PLP	407	Diseases and Insects of Forest and Shade Trees 4
(2)	Complete 9 credits from the following:		
	CSS	226L	Weed Science Laboratory 1
	CSS	326	Weed Science 2
	LA	140	Graphics and Two-Dimensional Design Studio 4
	HRT	214	Landscape and Turfgrass Business Operations 2
	HRT	310	Nursery Management 3
	HRT	323	Floriculture Production: Herbaceous Perennials and Annuals 3
	HRT	401	Advanced Horticultural Crop Physiology 3
	HRT	407	Horticulture Marketing 3
	HRT	460	Green Roofs and Walls 2
	HRT	475	International Studies in Horticulture 3

MINOR IN HORTICULTURE

The Minor in Horticulture, which is administered by the Department of Horticulture, is designed to provide an opportunity for students to gain a fundamental understanding of the science of horticulture and tailor their studies to food production, greenhouse and nursery crops, landscape design and management, or plant breeding and genetics.

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 Science Degree in Horticulture. With the approval of the department and college that administers 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. Students who plan to complete the requirements for the minor should consult an undergraduate advisor in Horticulture.

Requirements for the Minor in Horticulture

			CREDITS
Complete 18 credits from the following:			
1.	Both of the following courses (6 credits):		
	HRT	203	Introduction to Horticulture 3
	HRT	204	Plant Propagation and Use 3
2.	Complete 12 credits from the following:		
	HRT	205	Plant Mineral Nutrition 1
	HRT	211	Landscape Plants I 3
	HRT	212	Landscape Plants II 3
	HRT	213	Landscape Maintenance 2
	HRT	213L	Landscape Maintenance Field Laboratory 1
	HRT	218	Irrigation Systems for Horticulture 2
	HRT	218L	Irrigation Systems for Horticulture Laboratory 1
	HRT	219	Landscape Computer Aided Design 2
	HRT	221	Greenhouse Structures and Management 3
	HRT	242	Passive Solar Greenhouses for Protected Cultivation 1
	HRT	243	Organic Transplant Production 1
	HRT	251	Organic Farming Principles and Practices 3
	HRT	253	Compost Production and Use 1
	HRT	310	Nursery Management 3
	HRT	311	Landscape Design and Management Specifications 4
	HRT	323	Floriculture Production: Herbaceous Perennials and Annuals 3
	HRT	332	Tree Fruit Production and Management 2
	HRT	336	Viticulture and Berry Production 2
	HRT	341	Vegetable Production and Management 3
	HRT	361	Applied Plant Physiology 3
	HRT	403	Handling and Storage of Horticultural Crops 3
	HRT	407	Horticulture Marketing 3
	HRT	411	Landscape Contract Management 3
	HRT	460	Green Roofs and Walls 2
	HRT	475	International Studies in Horticulture 3

MINOR IN PLANT, ANIMAL AND MICROBIAL BIOTECHNOLOGY

The Minor in Plant, Animal and Microbial Biotechnology is available as an elective to students who are enrolled in Bachelor of Science degree programs with majors in animal science, biosystems engineering, fisheries and wildlife, food science, forestry, horticulture, and plant, soil and microbial sciences. The minor is administered by the Department of Horticulture.

The minor provides the opportunity for students who are enrolled in biological science–related undergraduate programs to become familiar with the concepts, techniques, and issues related to modern biotechnology. The minor is designed for students who may be planning to pursue graduate study in biotechnology–related disciplines or who may be interested in careers with corporations or agencies for which a basic familiarity with biotechnology is a prerequisite.

With the approval of the department and college that administer the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Plant, Animal and Microbial Biotechnology

The student must complete:

			CREDITS
1.	All of the following courses (8 credits):		
	BMB 401	Comprehensive Biochemistry	4
	HRT 461	Seminar in Plant, Animal and Microbial Biotechnology	1
	HRT 486	Biotechnology in Agriculture: Applications and Ethical Issues	3
2.	One of the following courses (3 or 4 credits):		
	ANS 314	Genetic Improvement of Domestic Animals	4
	CSS 350	Introduction to Plant Genetics	3
	IBIO 341	Fundamental Genetics	4
3.	One of the following courses (3 credits):		
	ANS 425	Animal Biotechnology	3
	BE 360	Microbial Systems Engineering	3
	CSS 451	Biotechnology Applications for Plant Breeding and Genetics	3
	MMG 445	Microbial Biotechnology (W)	3
4.	One of the following courses (1 credit):		
	ANS 490	Independent Study	1
	BE 490	Independent Study	1
	CSS 490	Independent Study	1
	HRT 492	Undergraduate Research	1

GRADUATE STUDY

The Department of Horticulture offers graduate study leading to the M.S. and Ph.D. degrees in Horticulture. In addition, students may work with Horticulture faculty to obtain M.S. and/or Ph.D. degrees in several interdepartmental graduate programs including Plant Breeding, Genetics and Biotechnology-Horticulture, Genetics, Cell and Molecular Biology, Molecular Plant Physiology, and Ecology and Evolution, and Behavior.

Faculty and students in MSU-Horticulture engage in scholarly research, teaching and outreach programs that are recognized nationally and internationally by our peer institutions and horticultural industries. Furthermore, our faculty and graduate students comprise an inclusive community of diverse backgrounds, cultures and experiences from across the U.S. and around the world.

The Horticulture graduate curriculum is flexible and can be tailored specifically to individual backgrounds, educational experiences, and career goals. Students can participate in interdisciplinary studies in such diverse areas as plant breeding, genetics, genomics, molecular biology, modeling, development, biochemistry, physiology and environmental response, sustainable and organic cropping systems, integration of plants with the human environment and marketing of horticultural/specialty crops. This integrated educational and research approach fosters new discoveries in the plant sciences and technological innovations in the sustainable production of food, ornamental and landscape crops. Numerous fellowships and grant-funded assistantships are available on a career interest and competitive basis.

For more information about the MSU-Horticulture Graduate Programs, visit our Web site at *https://www.canr.msu.edu/hrt/students/graduate_hort/*, or contact the MSU-Horticulture Graduate Programs office *www.hrt.msu.edu* or faculty members directly.

HORTICULTURE

Master of Science

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Students must have completed a Bachelor of Science degree or its equivalent in a plant related field, a basic course in horticulture, 15 credits in plant or soil sciences including plant physiology, and one course each in trigonometry, physics, and organic chemistry. Exceptions must be approved by the departmental Graduate Affairs Committee. Applicants lacking the necessary undergraduate background will be required to complete either collateral courses in addition to the requirements for the master's degree or a second Bachelor of Science degree with a major acceptable to the department.

Requirements for the Master of Science Degree in Horticulture

The student may elect either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under Plan A or Plan B.

The program of study for the Master of Science degree will include courses from departments other than the Department of Horticulture, but it should include at least 3 credits in the 800 series in horticulture in addition to research. For Plan A, at least 6 but not more than 10 credits of master's thesis research (Horticulture 899) is required. For Plan B, at least 2 but not more than 5 credits of research (Horticulture 898) is required. All programs of study are subject to departmental review.

A final oral examination on courses and research pursued during the program will be scheduled at the end of the student's final semester of enrollment.

Doctor of Philosophy

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Requirements for the Doctor of Philosophy Degree in Horticulture

An oral qualifying examination may be conducted by the guidance committee shortly after the student begins advanced graduate study to determine his or her qualifications and to provide a basis for developing the program of study.

At least 6 credits in the 800 series in horticulture are recommended. Three of the six credits may have been completed as part of master's degree requirements.

PLANT BREEDING, GENETICS and BIOTECHNOLOGY—HORTICULTURE

The Department of Horticulture offers Master of Science and Doctor of Philosophy degree programs in plant breeding, genetics and biotechnology–horticulture. Students meet the requirements for admission and the requirements both for Horticulture, as specified above, and for Plant Breeding, Genetics and Biotechnology, as specified in the statement on Interdepartmental Graduate Programs in Plant Breeding, Genetics and Biotechnology.

SCHOOL of PACKAGING

Matthew Paul Daum, Director

UNDERGRADUATE PROGRAMS

The School of Packaging offers a program of instruction leading to the Bachelor of Science degree. The program combines basic principles of physics, chemistry, mathematics, and materials science with specialized courses to prepare students for rewarding careers in industry. Career opportunities are plentiful since some form of packaging is involved in the production and movement to market of nearly every item of consumption in today's economy. In addition to careers in companies that use packaging, attractive opportunities are also available in the package supply industries. Package supplier industries include companies that print and convert paper and flexible plastic materials as well as manufacturers of such diverse items as bottles, cans, folding cartons, corrugated boxes, drums, wooden containers, pallets, pails, tubes, vials, and jars. Packaging impacts most functions in manufacturing firms so graduates may work in package development, production, quality control, research, sales, purchasing, marketing, testing, distribution, or technical services.

In its flexibility, the program allows students to leverage their personal skills and interests and to make individualized choices.

Admission as a Junior

Enrollments in the School of Packaging are limited. To be considered for admission to the major, the student must have:

1. Completed at least 56 credits.
2. Completed the following courses with a minimum grade of 2.0 in each course:
   a. Chemistry 141.
   b. Mathematics 133.
   c. Physics 231.

The student's cumulative grade–point average for all courses completed is considered in the admission decision. For additional information about admissions criteria and procedures, students should contact the School of Packaging.

Requirements for the Bachelor of Science Degree in Packaging

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 Packaging.

   The University's Tier II writing requirement for the Packaging major is met by completing Packaging 485. That course is referenced in item 3. below.

   Students who are enrolled in the Packaging major leading to the Bachelor of Science degree in the School of Packaging may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Chemistry 141,143 and 161; or Food Science 342 or Microbiology and Molecular Genetics 201. The completion of Chemistry 143 and 161 satisfies the laboratory requirement. Chemistry 141, 143 and 161; Food Science 342 or Microbiology and Molecular Genetics 201 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.
3. The following requirements for the major:

			CREDITS
a.	All of the following courses (58 credits):		
	CEM 141	General Chemistry	4
	CEM 143	Survey of Organic Chemistry	4
	CEM 161	Chemistry Laboratory I	1
	MTH 132	Calculus I	3
	MTH 133	Calculus II	4
	PKG 101	Principles of Packaging	3
	PKG 102	Introductory Packaging Seminar	2
	PKG 221	Packaging with Glass and Metal	2
	PKG 315	Packaging Decision Systems	3
	PKG 322	Packaging with Paper and Paperboard	4
	PKG 323	Packaging with Plastics	4
	PKG 410	Distribution Packaging Dynamics	4
	PKG 411	Package Development Technology	3
	PKG 432	Packaging Processes	4
	PKG 465	Packaging Value Chain	3
	PKG 485	Packaging Development (W)	4
	PHY 231	Introductory Physics I	3
	PHY 232	Introductory Physics II	3
b.	One of the following courses (3 credits):		
	FSC 342	Food Safety and Hazard Analysis Critical Control Point Program	3
	MMG 201	Fundamentals of Microbiology	3
c.	One of the following courses (3 or 4 credits):		
	STT 200	Statistical Methods	3
	STT 201	Statistical Methods	4
	STT 315	Introduction to Probability and Statistics for Business	3
	STT 351	Probability and Statistics for Engineering	3
d.	One of the following courses (3 credits):		
	MKT 327	Introduction to Marketing	3
	SCM 304	Survey of Supply Chain Management	3
e.	Completion of 9 credits of electives in packaging. Enrollment in a packaging internship completed under PKG 493 (up to 3 credits) and enrollment in a packaging overseas study program completed under		

PKG 491 (up to 3 credits) may be used towards this requirement with advisor approval.

GRADUATE STUDY

The School of Packaging offers graduate programs leading to the degrees of Master of Science and Doctor of Philosophy in packaging. Facilities and instrumentation are available for advanced study and research areas such as product and/or package damage in the physical distribution environment, barrier characteristics of packaging systems and materials, quality preservation and storage stability of packaged products, mechanical properties of packaging materials and systems, medical packaging, automatic identification, logistics, environmental impact and recycling of packaging materials, human factors in packaging, and packaging systems development and optimization. Programs of study and research are flexible and are designed to meet the needs of individual students.

Master of Science

Emphasis is placed upon a broad education in packaging that includes an area of study referenced above. Student participation in seminars and in the teaching program, where appropriate, is designed to broaden the student's background for future career activities.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Entering graduate students are expected to have a bachelor's degree in packaging or a related undergraduate field. Students lacking the equivalent of a bachelor's degree in packaging may be admitted provisionally and be required to complete collateral courses to make up any deficiencies. These collateral courses will not count toward degree requirements.

Requirements for the Master of Science Degree in Packaging

CREDITS

The master's degree program in packaging is available under either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under Plan A or Plan B. The student's program of study must be approved by either the student's guidance committee (Plan A) or the student's major professor (Plan B).

Requirements for Both Plan A and Plan B

The student must:

1. Complete 15 credits in Packaging courses at the 400-level or above. More than half of the 30 credits required for the degree must be at the 800-level or above.
2. Demonstrate an understanding of basic statistics.

Additional Requirements for Plan A

1. Packaging 825 and 860.
2. Packaging 805 or 815.
3. An additional 3 credits in 800-900 level Packaging courses excluding Packaging 888, 890, and 899.
4. At least six, but not more than eight, credits of Packaging 899.

Additional Requirements for Plan B

1. Packaging 805, 815, and 825.
2. An additional 6 credits in 800-900 level Packaging courses excluding Packaging 888, 890, and 899.
3. Pass a final Plan B examination.

Doctor of Philosophy

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, the student must meet the requirements specified below.

Admission

To be considered for admission to the Doctor of Philosophy degree program in packaging, an applicant must submit scores on the Graduate Record Examination (GRE) General Test.

To be admitted to the Doctor of Philosophy degree program in packaging on regular status, a student must have:

1. Completed a master's degree program in packaging, or in a related science or engineering area, for which a thesis was required, or a completed bachelor's degree in packaging or related science or engineering area with significant intensive research experience such as having peer-reviewed journal publications as the main author, or conducting several semesters of research work.
2. A grade–point average of at least 3.40 for the bachelor's or master's degree program.
3. Acceptable scores on the GRE General Test.

Provisional admission may be granted to an applicant who does not meet the above requirements but shows outstanding potential.

Guidance Committee

At least three members of the student's guidance committee must be faculty members in the School of Packaging, and at least one member must be a faculty member from outside the school.

Requirements for the Doctor of Philosophy Degree in Packaging

The student must:

	CREDITS
1. One of the following courses (3 credits):	
PKG 805 Advanced Packaging Dynamics	3
PKG 815 Permeability Shelf Life	3
2. Both of the following courses (7 credits):	
PKG 825 Polymeric Packaging Materials	4
PKG 860 Research Methods	3

3. An additional 3 credits of 800-level Packaging courses excluding PKG 890.
4. Complete 24 to 36 credits in PKG 999 Doctoral Dissertation Research.
5. Pass both a written and an oral comprehensive examination.
6. Complete a dissertation in one of the following areas of packaging: material science applications in packaging, food packaging, healthcare packaging, mass transport applications, or the dynamics and physical distribution aspects or human factors in packaging.
7. Successfully defend the dissertation.

SCHOOL of PLANNING, DESIGN and CONSTRUCTION

Ming-Han Li, Director

The School of Planning, Design, and Construction is jointly administered by the College of Agriculture and Natural Resources and the College of Social Science. The College of Agriculture and Natural Resources is the primary administrative unit. The school includes the academic programs that affect the various components of the built environment – construction management, landscape architecture, interior design, and urban and regional planning. Its educational discovery and engagement programs enhance the quality of life in a sustainable manner. The school serves the needs of students, the public, and the built environment via its undergraduate and graduate programs, research, conferences, and workshops offered through various outreach programs.

The school and its programs advance the university's bolder by design mission by creating, disseminating and applying knowledge to improve the quality of life in urban, regional and international communities. It accomplishes this mission, in part, by implementing, evaluating and disseminating innovative approaches developed through multidisciplinary research and collaborative community partnerships. The school provides a collaborative learning environment for faculty and students at Michigan State University to participate in a scholarship of engagement in generating and applying knowledge to address the contemporary challenges of communities.

The school also offers a dual degree program which provides an opportunity for students who are currently accepted into the Bachelor of Landscape Architecture program to enroll in graduate courses required in the Master of Arts Degree in Environmental Design while completing the last year and a half (three semesters) of their bachelor's degree program. Students interested in pursuing the dual degree of Bachelor of Landscape Architecture in Landscape Architecture and the Master of Arts in Environmental Design should contact the School of Planning, Design and Construction. Students are eligible to apply for admission to the dual degree program after completion of the first three years of curriculum requirements in the Bachelor of Landscape Architecture in Landscape Architecture.

UNDERGRADUATE PROGRAMS

The School of Planning, Design, and Construction exists to educate individuals for professional careers in areas impacting the built environment, spanning the life of a constructed edifice or entity, from planning, to design, and construction management. The school offers Bachelor of Science, Bachelor of Arts and Bachelor of Landscape Architecture degree programs. Individuals meeting the general University requirements for admission shown in the Undergraduate Education section of this catalog are enrolled in the Undergraduate University Division but may declare a major preference in the School of Planning, Design, and Construction. Refer to the specific degree program for further details regarding admission requirements and program curriculum.

The school offers programs leading to bachelor's degrees in the following fields:

Construction Management
Interior Design
Landscape Architecture
Urban and Regional Planning

The Bachelor of Science degree program with a major in urban and regional planning is offered through the College of Social Science. For information about this program, refer to the statement on the School of Planning, Design, and Construction in the College of Social Science section of this catalog.

CONSTRUCTION MANAGEMENT

The program is designed to provide a student with a background in managerial, technological, economic, social, political, and environmental aspects of residential and commercial construction. A systems approach is used and includes project management, construction science, land acquisition and development, real estate, finance, management, and marketing. Career opportunities include supervisory and managerial employment within commercial and residential contracting, land development, and real estate organizations; material distribution systems; financial institutions; and governmental agencies.

Admission as a Junior

Construction management builds upon a basic understanding of mathematics, physics, statistics, and economics to develop the skills necessary to manage construction projects. Prior to enrollment in the major, students must have demonstrated this basic understanding by a minimum performance in the courses listed and a minimum of 3.00 grade-point average in CMP courses listed in item 2. below. Enrollment in the construction management major is limited. Those seeking admission must at least meet the criteria listed below.

1. Completion of at least 56 credits.
2. Completion of the following courses with a minimum grade of 2.0 in each course:

MTH	124	Survey of Calculus I	3
PHY	231	Introductory Physics I	3
STT	200	Statistical Methods	3
Or			
STT	201	Statistical Methods	4
EC	201	Introduction to Microeconomics	3
Or			
EC	202	Introduction to Macroeconomics	3
CMP	101	Principles of Construction Management	2
CMP	124	Residential Construction Materials and Methods	3
CMP	210	Commercial Construction Methods	3
CMP	222	Statics and Strengths of Materials	3
CMP	230	Utility Systems	3

CMP 245 Principles of Green Building 3

While meeting all of the criteria above is necessary to be considered for admission to the Bachelor of Science Degree in Construction Management, it does not guarantee admission. Other factors such as MSU grade-point average, construction management grade-point average, work experience, and personal experience may also be considered.

For additional information about admissions criteria and procedures, students should contact the Construction Management Program in the School of Planning, Design, and Construction.

Requirements for the Bachelor of Science Degree in Construction Management

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 Construction Management.

   The University's Tier II writing requirement for the Construction Management major is met by completing Construction Management 385. That course is referenced in item 3. below.

   Students who are enrolled in the Construction Management major leading to the Bachelor of Science degree may complete an alternative track to Integrative Studies in Physical Sciences that consists of Physics 231.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The requirements of the College of Agriculture and Natural Resources for the Bachelor of Science degree.
3. The following requirements for the major:

		CREDITS
a. All of the following courses (62 credits):		
ACC 230	Survey of Accounting Concepts	3
CMP 101	Principles of Construction Management	2
CMP 124	Residential Construction Materials and Methods	3
CMP 210	Commercial Construction Methods	3
CMP 222	Statics and Strengths of Materials	3
CMP 230	Utility Systems	3
CMP 245	Principles of Green Building	3
CMP 305	Site Construction and Measurement	3
CMP 311	Construction Project Scheduling	3
CMP 315	Construction Quantity Surveying	3
CMP 322	Structural Systems	3
CMP 325	Real Estate Principles and Construction Finance	3
CMP 328	Building Information Modeling for Construction	3
CMP 385	Construction Documents and Contracts (W)	3
CMP 401	Construction Safety Management	3
CMP 415	Cost Estimating and Analysis	3
CMP 423	Construction Project Management	3
MGT 325	Management Skills and Processes	3
MTH 124	Survey of Calculus I	3
PHY 231	Introductory Physics I	3
PHY 232	Introductory Physics II	3
Students must have a minimum grade-point of 2.0 in each of the following courses: CMP 401, 415, and 423.		
b. One of the following courses (3 or 4 credits):		
CMP 445	Green and Energy Efficient Building Construction	3
CMP 453	Land Development	3
CMP 475	Practical Experiences in Construction Management	3
CMP 491	Special Topics in Construction Management	3 or 4
CMP 493	Professional Internship in Construction Management	3
PDC 403	Introduction to Domicology: Sustainable Built Environment	3
c. One of the following courses with a minimum grade-point of 2.0 (3 credits):		
CMP 435	Residential Building and Development Projects (W)	3
CMP 436	Commercial Building Projects (W)	3
CMP 492	Capstone Project Competitions	3
d. One of the following courses (3 or 4 credits):		
COM 100	Human Communication	3
COM 225	An Introduction to Interpersonal Communication	3
COM 240	Introduction to Organizational Communication	4
e. One of the following courses (3 or 4 credits):		
STT 200	Statistical Methods	3
STT 201	Statistical Methods	4
f. One of the following courses (3 credits):		
EC 201	Introduction to Microeconomics	3
EC 202	Introduction to Macroeconomics	3
g. One of the following courses (3 credits):		
FI 320	Introduction to Finance	3
GBL 323	Introduction to Business Law	3
MKT 327	Introduction to Marketing	3
SCM 304	Survey of Supply Chain Management	3

INTERIOR DESIGN

The Interior Design program is designed to prepare students for professional careers in interior design or for professional master's programs. The program provides students an opportunity to develop knowledge, skills, and insights needed to solve design problems creatively and effectively. Interior Design students will obtain fundamental and in-depth design knowledge, basic and advanced design skills, critical thinking strategies for evidence-based design solutions, and skills necessary for real-world practice and research. The curriculum enables the student to design and present solutions that support physical, psychological, social, and behavioral needs of all users and enhance health and well-being.

The Interior Design Program is accredited by the Council for Interior Design Accreditation (CIDA). The program meets the educational requirements for eligibility to sit for the National Council for Interior Design Qualification Examination (NCIDQ Exam).

Admission

The number of students admitted to the major in interior design is limited. To be considered for admission, a student must have:

1. Completed at least 28 credits.
2. An all–university grade–point average of 2.50 or better.
3. A grade–point average of 3.00 or better in the following courses: Interior Design 140, 142, 150, 152, and 240. Those courses are referenced in item 3. a. below in the Requirements for the Bachelor of Arts Degree in Interior Design.

In addition, transfer students must have previous design work evaluated by the department prior to placements in required courses.

Selective admissions are made at the end of spring semester for Michigan State University and transfer students from those students who have met the criteria referenced. The final selection of students to be admitted to the major is based on the cumulative grade–point average of all courses taken and a grade–point average calculated for selected courses and portfolio review by faculty members.

Requirements for the Bachelor of Arts Degree in Interior Design

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 Interior Design.

The University's Tier II writing requirement for the Interior Design major is met by completing Interior Design 442. This course is referenced in item 3. a. below.

The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.

2. The completion of the requirements of the College of Agriculture and Natural Resources for the Bachelor of Arts degree.
3. The following requirements for the major:

		CREDITS
a. All of the following courses (57 credits):		
IDES 140	Design for Living	3
IDES 142	Design Theory Studio	3
IDES 150	Interior Design Drafting	3
IDES 152	Interior Environments	3
IDES 240	Computer–Aided Design for Designers	3
IDES 250	3D Modeling and Visualization	3
IDES 252	Interior Design Synthesis I	4
IDES 340	Interior Design Specifications and Workroom Practices	3
IDES 342	Interior Design: Human Dimensions	3
IDES 343	Interior Design Presentation and Media	3
IDES 344	History of Interior Design: Ancient Through Rococo	3
IDES 350	Interior Design Lighting and Environmental Systems	3
IDES 352	Interior Design Synthesis II	4
IDES 354	History of Interior Design: Neo–Classical Through Modern	3
IDES 393	Introduction to Professional Practice	1
IDES 440	Contemporary Design Issues	2
IDES 441	Interior Design Open Office Systems	1
IDES 442	Interior Design Programming (W)	3
IDES 451	Interior Design Professional Practice	2
IDES 452	Interior Design Synthesis III	4

b. Any two of the following History of Art options (6 to 9 credits):
(1) Any History of Art course (3 to 4 credits).
(2) Any History of Art course (3 to 4 credits).
(3) IDES 490 Independent Study (3 to 5 credits) earned through the Interior Design Education Abroad program.
(4) IDES 456 Historic Preservation and Sustainability (3 credits).

LANDSCAPE ARCHITECTURE

Established in 1898, the undergraduate Bachelor of Landscape Architecture program provides a diverse learning experience which strives for balancing ideology, design, technology, art and science toward creating a sustainable and resilient world. The program curriculum prepares students to be responsible landscape architects and fulfilled individuals with a breadth and depth of professional knowledge, bridged with the employability skills to advance in practice. Graduates master the scientific evidence-based approach in creating design solutions across scales with the integration of art, science and human interaction, applying their knowledge to diverse and immersive project types from local to international settings.

The program includes professional courses in design theory and graphic communications, environmental perception, history, and plant materials and their uses; technical aspects of site development, design applications for representative land uses; site planning for typical projects; community planning, housing and recreational development; and urban and regional design and planning.

The program offers meaningful opportunities and challenges within the classroom and on community projects, which prepare the student to communicate through writing, speech and graphics.

The Bachelor of Landscape Architecture program at Michigan State University has been accredited by the Landscape Architecture Accreditation Board (LAAB) since 1952.

Honors Study

Students interested in honors programs in landscape architecture should consult with an academic advisor.

Admission

The number of students who can be admitted as sophomores to the landscape architecture major is limited. To be admitted to the Bachelor of Landscape Architecture program, the following factors will be taken into consideration:

1. Completion of 28 credits.
2. Submission of a completed Landscape Architecture application package by the deadline specified by the School.
3. Achieve a grade of 2.0 or higher in the following core Landscape Architecture courses:
   a. LA 140 Graphics and Two-Dimensional Design Studio
   b. LA 141 Graphics and Three-Dimensional Design Studio
   c. LA 200 Introduction to Landscape Architecture
4. Completion of the University, College and School mathematics requirement referenced in item 2. b. (2) below.
5. Completion of PDC 120 Planning and Design Digital Graphics.

Admissions are determined by the faculty on the basis of the relative qualifications of applicants and the enrollment capacity in the program. Admission is competitive. Transfer students and students with 28 or more credits who want to change their major to Landscape Architecture may have previous design work evaluated by the program prior to placement in landscape architecture second-year courses and above.

Requirements for the Bachelor of Landscape Architecture Degree in Landscape Architecture

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of this catalog; 130 credits, including general elective credits, are required for the Bachelor of Landscape Architecture degree in Landscape Architecture.

   Students who are enrolled in the Landscape Architecture major leading to the Bachelor of Landscape Architecture degree in the School of Planning, Design and Construction may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Plant Biology 105, an ISP course and ISP laboratory. The completion of the ISP course and ISP laboratory satisfies the laboratory requirement. Plant Biology 105 may be counted toward both the alternative track and the requirements for the major referenced in item 2. below.

   The completion of Mathematics 116, or Mathematics 103 and 114, or Mathematics 103 and Statistics and Probability 200 or 201 referenced in requirement 2. below may also satisfy the University mathematics requirement.

   The University's Tier II writing requirement for the Landscape Architecture major is met by completing Landscape Architecture 480. That course is referenced in item 2. c. below.
2. The following requirements for the major:

	CREDITS
a. A minimum grade of 2.00 in all Landscape Architecture courses referenced in requirement 2.c. below.	
b. Collateral Courses (30 to 35 credits):	
(1) All of the following courses (22 credits):	

HRT	211	Landscape Plants I	3
HRT	212	Landscape Plants II	3
HRT	311	Landscape Design and Management Specifications	4
ISS	310	People and the Environment (I)	4
PDC	120	Planning and Design Digital Graphics	2
PLB	105	Plant Biology	3
UP	424	Geographic Information Systems and Design Tools for Planning	3

(2) One of the following groups (5 to 7 credits):

(a) MTH	116	College Algebra and Trigonometry	5
(b) MTH	103	College Algebra	3
MTH	114	Trigonometry	3
(c) MTH	103	College Algebra	3
STT	200	Statistical Methods	3
or			
STT	201	Statistical Methods	4

(3) Students must demonstrate AutoCAD proficiency through transfer c credit, waiver or completion of the following course (0 to 3 credits):

IDES	240	Computer-Aided Design for Designers	3

(4) One of the following courses (3 credits):

EC	201	Introduction to Microeconomics	3
EC	202	Introduction to Macroeconomics	3

c. Landscape Architecture Courses: All of the following courses (61 credits):

LA	140	Graphics and Two-Dimensional Design Studio	4
LA	141	Graphics and Three-Dimensional Design Studio	4
LA	200	Introduction to Landscape Architecture	3
LA	230	Site Construction Materials and Methods	4
LA	231	Landscape Site Engineering	4
LA	242	Creating Space Studio	4
LA	243	Place Making Studio	4
LA	332	Advanced Landscape Site Engineering	4
LA	344	Connections of Scale Studio	5
LA	345	Design Development Studio	5
LA	390	Landscape Architecture Field Studies	3
LA	421	Drawing as Knowing	4
LA	447	Juried Design Studio	5
LA	448	Regional Environmental Design Studio	2
LA	449	Landscape Architecture Design Studio	3
LA	480	Professional Practice in Landscape Architecture (W)	3

d. Directed Electives: 14

A minimum of 14 additional credits in courses approved by the student's academic advisor and program director.

Courses that are used to satisfy the University Integrative Studies and writing requirements may not be used to satisfy this requirement. Courses used to satisfy the AutoCAD proficiency requirement referenced in item 2 b. (3) above may not be used to satisfy this requirement.

School of Planning, Design and Construction Dual Degree Program: Bachelor of Landscape Architecture in Landscape Architecture and Master of Arts in Environmental Design

The dual degree program provides an opportunity for students who are currently accepted into the Bachelor of Landscape Architecture program to enroll in graduate courses required in the Master of Arts Degree in Environmental Design while completing the last year and a half (three semesters) of their bachelor's degree program. Students interested in pursuing the dual degree of Bachelor of Landscape Architecture in Landscape Architecture and the Master of Arts in Environmental Design should contact the School of Planning, Design and Construction. Students are eligible to apply for admission to the dual degree program after completion of the first two years of curriculum requirements in the Bachelor of Landscape Architecture in Landscape Architecture. Admission to Master of Arts in Environmental Design must be approved before beginning graduate-level course work in the fourth year of the bachelor's degree program. Upon completion of the requirements for both the Bachelor of Landscape Architecture degree and the Master of Arts degree, both degrees are awarded simultaneously. The Master of Arts degree will not be awarded until the student has completed the requirements for the Bachelor of Landscape Architecture degree.

To be admitted to the dual degree program, the following factors will be taken into consideration:

1. Overall MSU grade-point average.
2. Grade-point average in all landscape architecture courses.
3. Evidence of creative works and service.
4. A written essay.

Admission is competitive and enrollment is limited for each entering class. Students who are not selected for admission into the dual degree program will be advised of other degree options. Students may reapply for admission during the following admissions cycle.

A student who is admitted to the dual degree program must:

1. Satisfy all of the requirements for the Bachelor of Landscape Architecture degree program to which the student was originally admitted.
2. Satisfy all of the requirements for the Master of Arts degree in Environmental Design.

Students admitted to the dual degree program will apply 9 credits of course work toward the master's program for qualifying 400-level and above course work taken at the undergraduate level at Michigan State University. The 9 credits are applied toward the credit requirement of the master's degree.

LINKED BACHELOR'S-MASTER'S DEGREE IN CONSTRUCTION MANAGEMENT

Bachelor of Science Degree in Construction Management
Master of Science Degree in Construction Management

The department welcomes applications from Michigan State University Construction Management undergraduate students at the end of their junior year. Admission applications must be made after the spring semester of the junior year when CMP 311, 315, and 385 have been completed, for an anticipated Spring graduation. Admission to the program requires a cumulative minimum undergraduate grade-point average of 3.5 and a grade-point average of 3.5 in all Construction Management (CMP) courses completed and an approved program of study for the Master of Science degree in Construction Management at the time of admission, in addition to three letters of recommendation and a personal statement. Admission to the Linked Bachelor's-Master's program allows the application of up to 9 credits toward the master's program for qualifying 400-level and above course work taken at the undergraduate level at Michigan State University or another postsecondary accredited institution of comparable academic quality. The number of approved credits, not to exceed 9, are applied

toward the credit requirement of the master's degree. Credits applied to the Linked Bachelor's-Master's program are not eligible to be applied to any other graduate degree program.

GRADUATE STUDY

Graduate study may lead to a Master of Arts, Master of Science, Master of Urban and Regional Planning or Doctor of Philosophy degree. The School has expertise and facilities available for advanced study and research in the following areas: Construction Management; Environmental Design; Planning, Design and Construction; and Urban and Regional Planning. The School offers programs leading to graduate degrees in the following fields:

Graduate Certificate
Real Estate Development and Construction
Urban Resilient Redevelopment
Master of Arts
Environmental Design
Master of Science
Construction Management
Master of International Planning Studies
International Planning Studies
Master of Urban and Regional Planning
Urban and Regional Planning
Doctor of Philosophy
Planning, Design and Construction

The Master of International Planning Studies degree program with a major in international planning studies and the Master of Urban and Regional Planning degree program with a major in urban and regional planning are offered through the College of Social Science. For information about those programs, refer to the statement on the School of Planning, Design, and Construction in the College of Social Science section of this catalog.

CONSTRUCTION MANAGEMENT

The Master of Science degree program with a major in construction management is designed to provide breadth in the managerial, technological, economic, and environmental aspects of construction. The program is also designed to provide depth through a systems approach encompassing project management, estimating, scheduling and project controls, land acquisition and development, architectural and engineering design, construction technology, real estate, finance, business management, and marketing.

The master's program in construction management is available under either Plan A (with thesis) or Plan B (without thesis). Students who anticipate careers in teaching, consulting, or research, or who plan to pursue a doctoral program, are encouraged to select Plan A. After the student's academic advisor has approved the student's program of study under Plan A, the student may not pursue the program under Plan B without the approval of the school. Students who are enrolled in the master's program in construction management often take courses in business management, labor and industrial relations, civil engineering, human environment and design, resource development, urban planning, statistics, or education, in addition to courses in the major. Students may work directly with one or more faculty members on an independent basis to cover material that is not available through regular courses.

Master of Science

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

To be considered for admission to the master's degree program in construction management, an applicant must take the Graduate Record Examination General Test and have the scores submitted to the department.

To be admitted to the program on regular status, an applicant must:

1. Have a Bachelor of Science degree in construction management or in a related area such as architecture, business, design, engineering, management, or urban planning.
2. Have a cumulative grade–point average of at least 3.0 (on a 4.00 scale) for the undergraduate program.
3. Have experience in the construction industry acceptable to the department.
4. Have completed as part of the undergraduate program 3 semester credits of introductory calculus (MTH 124 Survey of Calculus I or its equivalent); 3 semester credits of introductory physics (PHY 231 Introductory Physics I or its equivalent).

Applicants who do not meet the requirements referenced in item 1. and 4. above may be required to complete specified collateral courses with a grade-point average of at least 3.00. These courses will not count toward the degree. The guidance committee will determine which courses are required as collateral courses for each applicant.

Requirements for the Master of Science Degree in Construction Management

The student must complete a total of 30 credits for the degree under Plan A (with thesis) or 33 credits for the degree under Plan B (without thesis). For students who elect independent study courses, including Construction Management 890, no more than 6 credits under Plan A and 9 credits under Plan B may be counted toward the requirements for the degree. The student's program of study must be approved by the student's academic advisor and must meet the requirements specified below:

CREDITS

Requirements for Plan A

1. A minimum of 18 credits in 800–900 level courses.
2. All of the following courses:
   - CMP 817 Construction Project Management and Information Systems 3
   - CMP 822 Contracts and Legal Issues in Construction 3
   - CMP 893 Elements and Methods of Research for Built Environment 3
3. One additional 800-level Construction Management course, excluding Construction Management 890, 898, and 899. Students without a background in construction methods, project scheduling and estimating must complete Construction Management 801, 811 and 815 in partial fulfillment of this requirement.
4. One 400-level course or above in statistics.

Additional Requirements for Plan A

1. Complete 6 credits of Construction Management 899. No more than 6 credits may be counted toward the requirements for the degree under Plan A.
2. Complete and defend a master's thesis acceptable to the student's guidance committee.

Requirements for Plan B

1. A minimum of 24 credits in 800-900 level courses.
2. All of the following courses:
   CMP 817 Construction Project Management and Information Systems 3
   CMP 822 Contracts and Legal Issues in Construction 3
   CMP 893 Elements and Methods of Research for Built Environment 3
3. One additional 800-level Construction Management course, excluding Construction Management 890, 898, and 899. Students without a background in construction methods, project scheduling and estimating must complete Construction Management 801, 811 and 815 in partial fulfillment of this requirement.
4. One 400-level course or above in statistics.

Additional Requirements for Plan B

Completion of one of the following:

1. Successfully complete the final examination given by the guidance committee.
2. Pass the AIC Level 1 certification examination.
3. Complete 3 credits of Construction Management 898. No more than 3 credits may be counted towards the requirements for the degree under Plan B. Successfully complete the Plan B report acceptable to the guidance committee.

Transfer Credits

No more than 9 semester credits of graduate course work (excluding research and thesis credits) may be transferred from other recognized educational institutions.

ENVIRONMENTAL DESIGN

Master of Arts

The College of Agriculture and Natural Resources in cooperation with the Landscape Architecture program and the Interior Design program in the School of Planning, Design and Construction and the Departments of Horticulture and Community, Agriculture, Recreation and Resource Studies participate in the Master of Arts degree in Environmental Design. The College of Agriculture and Natural Resources is the primary administrative unit.

The purpose of this master's degree is to train students to address the environment-related issues in research and design using scientific, evidence-based approach. The program focuses on the complex interdisciplinary nature for sustainable environments. Students will develop a highly individualized plan of study with a focus in sustainable built, natural, and virtual environments. Students who are enrolled in the program will be able to take courses on ecology, human environment and design, construction management, social science, environmental resource development, city and regional planning, statistics or education, in addition to courses in the major.

The Master of Arts Degree in Environmental Design addresses four areas of professional development. These include:

1. acquisition of in-depth knowledge in the area of environmental design theory;
2. development of problem-solving skills within an interdisciplinary professional context;
3. development of technological expertise and a knowledge base in a selected area of environmental research and design; and
4. a greater command of analytical, graphic, written, and oral communication skills.

All students will take a core of three courses in environmental design (theory, seminar, and studio), in addition to either a Plan A (with thesis) or Plan B (without thesis). Students will elect relevant courses in fields which pertain to their design area of interest.

The program is planned to provide an alternative to traditional professional degrees by addressing the needs of students with undergraduate design backgrounds who wish to work in an interdisciplinary setting while pursuing an area of individual interest.

Admission

To be considered for admission to the Master of Arts in Environmental Design, the applicant must have:

1. completed a bachelor's degree in a design related field such as horticulture, park and recreation, interior design, landscape architecture, or architecture.
2. a cumulative grade-point average of at least 3.0 in design and technology courses with an academic background sufficient to indicate probable success in the program.
3. satisfactory scores on the Graduate Record Examination General Test (GRE) as judged by the environmental design faculty. No substantive area GRE examinations are required.
4. acceptance as an advisee by a participating environmental design faculty member.

In addition to meeting the requirements of the university and the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Requirements for the Master of Arts Degree in Environmental Design

Students in the Master of Arts in Environmental Design must complete a total of 33 credits for the degree under either Plan A (with thesis) or Plan B (without thesis). A minimum of 17 of those credits must be at the 800-level or above, distributed as follows:

CREDITS

1. All of the following core courses (12 credits):
   IDES 891 Topics in Interior Design and Human Environment 3
   LA 816 Environmental Design Theory 3
   LA 817 Environmental Design Studio 3
   LA 883 Environmental Design Seminar 3
2. Guided elective courses related to the student's area of design interest, chosen in consultation with the student's academic advisor.

For **Plan A** , students must complete a minimum of 6 and a maximum of 9 credits of Master's Thesis Research (899) in one of the following departments: Planning, Design and Construction; Horticulture; or Community, Agriculture, Recreation and Resource Studies. They must also prepare a written thesis and pass an oral examination.

For **Plan B**, students must complete 6 credits of Master's Research (898) in one of the following departments: Planning, Design and Construction; Horticulture; or Community, Agriculture, Recreation and Resource Studies. They must also complete either a major planning or design project or pass a comprehensive examination.

PLANNING, DESIGN AND CONSTRUCTION

Doctor of Philosophy

The many aspects of our built and natural environment – buildings, facilities, interior spaces, infrastructure, neighborhoods, and communities – are an integral part of our society. Every new space and structure serves to define and shape a community's personality. Poor planning design and/or construction can compromise a community's appearance and drain its resources. Conversely, well-planned, designed and constructed environments sustain and enrich a community.

The Doctor of Philosophy in Planning, Design and Construction with a concentration in construction management, environmental design, or urban and regional planning will enable students to meet future challenges. Graduates of this program will possess the knowledge and skills necessary to understand the effects of plans, regulations, design, materials, project management techniques, and construction systems on the economic, environmental, and social concerns of stakeholders and society.

Admission

To be considered for regular admission to the Doctor of Philosophy degree program in Planning, Design and Construction, an applicant must have all of the following:

1. A master's degree in a related field.
2. A cumulative grade-point average of 3.5 on a 4.0 scale.
3. GRE scores no lower than 301 in combined verbal and quantitative and at least 4.0 analytical.
4. TOEFL scores (for international applicants):
   a. Paper-based – no lower than 575 (with no sub scores below 52)
   b. Computer-based – no lower than 235 (with no sub scores below 19)
   c. Internet-based – no lower than 90 (with no sub scores below 19 for reading, listening, and speaking, and no writing sub score below 22)

Additionally, students are encouraged to submit a sample of scholarly work or a portfolio of design work. Depending on the proposed area of concentration, the school may ask for additional background information.

Provisional admission may be granted to an applicant who does not meet the above requirements but demonstrates outstanding potential. Collateral course work will not count towards degree requirements.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources and the College of Social Science, the student must meet the requirements specified below.

Guidance Committee

The guidance committee should be comprised of at least four faculty members. The chairperson and one other committee member should be from the student's area of concentration within the School, a third member can be from the student's area of concentration or another area of concentration within the School, and a fourth member must be from outside the school.

Requirements for the Doctor of Philosophy Degree in Planning, Design and Construction

	CREDITS
The student must:	
1. Complete 9 credits in the following core courses:	
PDC 901 Integrated Approach to Planning, Design and Construction	3
PDC 992 Advanced Research Methods in Planning, Design and Construction	3
An advanced statistics course or other related course	3
2. Complete a minimum of four additional courses related to the area of concentration as specified by the student's guidance committee. Concentration areas include: construction management, environmental design, or urban and regional planning.	12
3. Pass both a written and oral comprehensive examination.	
4. Complete 24 credits of Planning, Design and Construction 999.	
5. Complete and successfully defend a dissertation in an area related to area of concentration.	

GRADUATE CERTIFICATE IN REAL ESTATE DEVELOPMENT AND CONSTRUCTION

The Graduate Certificate in Real Estate Development and Construction trains students to gain knowledge about real estate development and to integrate sustainable principles that shape our built environments for current and future generations. The program is available online only.

Requirements for the Graduate Certificate in Real Estate Development and Construction

	CREDITS
Students must complete 9 credits from the following:	
PDC 853 Real Estate Finance and Commercial Development	3
PDC 858 Land Use Planning and Housing	3
PDC 859 Construction Management and Real Estate Case Studies	3

GRADUATE CERTIFICATE IN URBAN RESILIENT REDEVELOPMENT

The Graduate Certificate in Urban Resilient trains students to gain knowledge about urban resilient redevelopment and to integrate sustainable principles that shape our built environments for current and future generations. The program is available online only.

Requirements for the Graduate Certificate in Urban Resilient Redevelopment

	CREDITS
Students must complete 9 credits from the following:	
PDC 803 Advanced Domicology: Sustainable Built Environment	3
PDC 858 Land Use Planning and Housing	3
PDC 878 Redevelopment and the Climate Resilient City	3

DEPARTMENT of PLANT, SOIL and MICROBIAL SCIENCES

Wei Zhang, Chairperson

UNDERGRADUATE PROGRAMS

The department offers a Bachelor of Science degree in Crop and Soil Sciences, with three concentrations: agronomic sciences, turfgrass management, and advanced studies. The undergraduate curriculum is designed to prepare students to apply scientific principles of crop and soil management for careers in agriculture, agribusiness, turfgrass management, government agencies, and related areas.

Students in agronomic science study the close relationship between crop science and soil science. The goal of the crop scientist is to increase plant production, grain quality, and profit by utilizing genetics, breeding, physiology, and pest management. The goal of the soil scientist is to improve soil fertility and the chemical, physical, and microbial characteristics of the soil. These two subjects are combined in agronomic sciences to develop an integrated approach to the management of crops and soils. Demands for new applications are constantly emerging. There are many complex interactions in plant growth and genetics; the physical, chemical, and biological factors involved in improving crop yields; and the soil-plant-animal relationships that determine the sustainability of cropping systems. Department faculty are nationally and internationally recognized for excellence in both the basic and applied plant and soil sciences and work as partners with agricultural industries to serve agriculture, the citizens of Michigan, the nation, and the world. Students are well prepared for employment in various positions within the food production industry to help feed a burgeoning human population, while understanding the importance of agricultural sustainability. They are highly sought by agribusinesses and governmental agencies to help address food production issues for the future.

The Turfgrass Management concentration encompasses many of the same agronomic principles and applies them to the management of grasses for use on golf courses, athletic fields, home lawns, and recreational areas. Turfgrass adds beauty to the landscape, minimizes sound and air pollution, stabilizes the soil, and reduces the heat load on homes through transpirational cooling.

Students in the advanced studies concentration are fully prepared to accept employment upon graduation, but take additional courses to prepare them for graduate study. These include additional mathematics, chemistry, biochemistry, and statistics courses.

The department also offers minors in agronomy, applied development in international agriculture and natural resources, environmental soil science, sustainable agriculture and food systems, and in turfgrass management.

CROP and SOIL SCIENCES

The Crop and Soil Sciences major is based upon the continuously expanding knowledge base of the biological and physical sciences and the utilization of those sciences to produce food and fiber of high quality on a competitive basis to promote sustainability, and to obtain increased nutrient–use efficiency, proper land use, increased plant adaptation to environmental and other stresses, decreased soil erosion, and decreased environmental pollution. Crop and soil scientists utilize the principles of genetics, plant breeding, crop physiology, weed science, turfgrass science, soil physics, soil fertility, soil genesis and classification, and soil chemistry.

Majors complete a common core of courses and one concentration: Agronomic Sciences, Turfgrass Management or Advanced Study.

1. Agronomic Sciences is designed to prepare students to work as agronomists. These scientists have career opportunities in agricultural business and in government agencies such as departments of agriculture and/or natural resources, the Natural Resources Conservation Service and the Extension Service. They also work and consult pest management specialists and managers of grower organizations and with land appraisal firms, agencies involved with environmental issues, and in international agriculture.
2. Turfgrass Management is designed to prepare students for the rapidly expanding area of urban agriculture. Graduates have career opportunities in the industries involved with management of golf courses, athletic fields, lawns and park and grounds management.
3. Advanced Study is specifically designed for those students who plan to pursue graduate studies. Although students who complete the other concentrations may pursue graduate study, this concentration requires the completion of advanced levels of mathematics and advanced courses in the basic sciences.

Students may also complete a specialization in international agriculture, agribusiness management, agriculture and natural resources biotechnology, connecting learning, environmental economics, food industry management, or environmental studies. Students may qualify to teach agriscience in high school under a plan of study cooperatively developed by the student's faculty advisor and the Department of Community, Agriculture, Recreation and Resource Studies. For additional information visit *http://www.reg.msu.edu/UCC/specializations.aspx*.

Requirements for the Bachelor of Science Degree in Crop and Soil Sciences

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 Crop and Soil Sciences.

   The University's Tier II writing requirement for the Crop and Soil Sciences major is met by completing two courses as specified below:

Agronomic Sciences: Both of the following courses: Crop and Soil Sciences 313 and 492. Those courses are referenced in items 3. a., and 3. b. below.

Turfgrass Management: Both of the following courses: Crop and Soil Sciences 313 and 492. Those courses are referenced in items 3. a., and 3. b. below.

Advanced Study: Both of the following courses: Crop and Soil Sciences 313 and 492. Those courses are referenced in items 3. a., and 3. b. below.

Students who are enrolled in the Agronomic Sciences or Turfgrass Management concentrations of the Crop and Soil Sciences major leading to the Bachelor of Science degree in the Department of Plant, Soil and Microbial Sciences, may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Plant Biology 105 and 106 and Chemistry 141, 143, and 161. The completion of Plant Biology 106 and Chemistry 161 satisfies the laboratory requirement. Plant Biology 105 and 106 and Chemistry 141, 143, and 161 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

Students who are enrolled in the Advanced Study concentration of the Crop and Soil Sciences major leading to the Bachelor of Science degree in the Department of Plant, Soil and Microbial Sciences, may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Plant Biology 105 and Chemistry 151, 152, and 161. The completion of Chemistry 161 satisfies the laboratory requirement. Plant Biology 105 and Chemistry 151, 152, and 161 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.

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

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. For students who select the Advanced Study Option, the completion of Mathematics 124 and 126 satisfies the College's mathematics requirement.

3. The following requirements for the major:

		CREDITS
a. All of the following courses (9 credits):		
CEM 161	Chemistry Laboratory I	1
CSS 110	Computer Applications in Agronomy	2
CSS 210	Fundamentals of Soil Science	3
CSS 313	Data Interpretation and Writing in the Agronomic Sciences (W)	2
CSS 492	Professional Development Seminar II	1
b. One of the following three concentrations (63 to 74 credits):		
Agronomic Sciences (67 to 70 credits):		
(1)All of the following courses (55 credits):		
CEM 141	General Chemistry	4
CEM 143	Survey of Organic Chemistry	4
CSS 101	Introduction to Crop Science	3
CSS 101L	Introduction to Crop Science Laboratory	1
CSS 192	Professional Development Seminar I	1
CSS 226L	Weed Science Laboratory	1
CSS 326	Weed Science	2
CSS 330	Soil Chemistry	2
CSS 340	Applied Soil Physics	2
CSS 350	Introduction to Plant Genetics	3
CSS 360	Soil Biology	3
CSS 470	Soil Resources	3
CSS 480	Soil Fertility and Management	3
CSS 488	Agricultural Cropping Systems: Integration and Problem Solving	3
CSS 493	Professional Internship in Crop and Soil Sciences	3
ENT 404	Fundamentals of Entomology	4
MTH 116	College Algebra and Trigonometry	5
PLB 105	Plant Biology	3
PLB 106	Plant Biology Laboratory	1
PLP 405	Plant Pathology	4
(2)One of the following courses (3 credits):		
HRT 361	Applied Plant Physiology	3
PLB 301	Introductory Plant Physiology	3
(3)One of the following courses (2 or 3 credits):		
CSS 222	New Horizons in Biotechnology	2
CSS 441	Plant Breeding and Biotechnology	3
CSS 451	Biotechnology Applications for Plant Breeding and Genetics	3
(4)One of the following courses (3 credits):		
EC 201	Introduction to Microeconomics	3
EC 202	Introduction to Macroeconomics	3
(5)Two of the following courses (4 to 6 credits):		
CSS 135	Crop Scouting and Investigation	3
CSS 151	Seed and Grain Quality	2
CSS 201	Forage Crops	3
CSS 212	Advanced Crop Production	2
Turfgrass Management (67 credits):		
(1)All of the following courses (64 credits):		
CEM 141	General Chemistry	4
CEM 143	Survey of Organic Chemistry	4
CSS 178	Turf Irrigation	3
CSS 181	Pesticide and Fertilizer Application Technology	3
CSS 226L	Weed Science Laboratory	1
CSS 232	Turfgrass Management	4
CSS 262	Turfgrass Management Seminar	1
CSS 267	Performance Turf Design and Construction	2
CSS 269	Turfgrass Strategies: Integration and Synthesis	2
CSS 272	Turfgrass Soil Fertility	2
CSS 326	Weed Science	2
CSS 330	Soil Chemistry	2
CSS 340	Applied Soil Physics	2
CSS 350	Introduction to Plant Genetics	3
CSS 360	Soil Biology	3
CSS 282	Turfgrass Physiology	2
CSS 470	Soil Resources	3
CSS 493	Professional Internship in Crop and Soil Sciences	3
EC 201	Introduction to Microeconomics	3
ENT 264	Turfgrass Entomology	3
MTH 116	College Algebra and Trigonometry	5
PLB 105	Plant Biology	3
PLB 106	Plant Biology Laboratory	1
PLP 266	Turf Pathology	3
(2)One of the following courses (3 credits):		
HRT 361	Applied Plant Physiology	3
PLB 301	Introductory Plant Physiology	3
Advanced Study (74 credits):		
(1)All of the following courses (62 credits):		
BMB 401	Comprehensive Biochemistry	4
CEM 151	General and Descriptive Chemistry	4
CEM 152	Principles of Chemistry	3
CEM 251	Organic Chemistry I	3
CEM 252	Organic Chemistry II	3
CSS 101	Introduction to Crop Science	3
CSS 101L	Introduction to Crop Science Laboratory	1
CSS 192	Professional Development Seminar I	1
CSS 226L	Weed Science Laboratory	1
CSS 326	Weed Science	2
CSS 330	Soil Chemistry	2
CSS 340	Applied Soil Physics	2
CSS 350	Introduction to Plant Genetics	3
CSS 360	Soil Biology	3
CSS 470	Soil Resources	3
CSS 480	Soil Fertility and Management	3
CSS 488	Agricultural Cropping Systems: Integration and Problem Solving	3
CSS 499	Undergraduate Research	3
ENT 404	Fundamentals of Entomology	4
MTH 132	Calculus I	3
PLB 105	Plant Biology	3
PLB 106	Plant Biology Laboratory	1
PLP 405	Plant Pathology	4
(2)One of the following courses (3 credits):		
HRT 361	Applied Plant Physiology	3
PLB 301	Introductory Plant Physiology	3
(3)One of the following courses (3 credits):		
CSS 441	Plant Breeding and Biotechnology	3
CSS 451	Biotechnology Applications for Plant Breeding and Genetics	3
(4)One of the following courses (3 credits):		
EC 201	Introduction to Microeconomics	3

EC 202 Introduction to Macroeconomics 3
(5) The following course:
STT 421 Statistics I 3

MINOR IN AGRONOMY

The Minor in Agronomy, which is administered by the Department of Plant, Soil and Microbial Sciences, is designed to serve students with majors in fields other than Crop and Soil Sciences who are interested in agronomy and who plan to pursue careers in agriculture for which a basic familiarity with the science of cropping systems is important. The minor will provide an opportunity for students to gain a fundamental understanding of the science of food production, including crop management, soil management, and plant breeding and biotechnology.

This 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 Science Degree in Crop and Soil Sciences or the Bachelor of Science Degree in Environmental Soil Science. 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.

Students who plan to complete the requirements of the minor should consult the Department of Plant, Soil and Microbial Sciences and have their program of study approved in advance and in writing.

Requirements for the Minor in Agronomy

Complete a minimum of 16 credits from the following:

	CREDITS
1. All of the following courses (10 credits):	
CSS 101 Introduction to Crop Science	3
CSS 101L Introduction to Crop Science Laboratory	1
CSS 210 Fundamentals of Soil Science	3
CSS 488 Agricultural Cropping Systems: Integration and Problem Solving	3
2. Complete 6 credits from the following courses:	
CSS 135 Crop Scouting and Investigation	3
CSS 151 Seed and Grain Quality	2
CSS 201 Forage Crops	3
CSS 212 Advanced Crop Production	2
CSS 222 New Horizons in Biotechnology	2
CSS 251 Organic Farming Principles and Practices	3
CSS 326 Weed Science	2
and	
CSS 226L Weed Science Laboratory	1
CSS 330 Soil Chemistry	2
CSS 340 Applied Soil Physics	2
CSS 350 Introduction to Plant Genetics	3
CSS 360 Soil Biology	3
CSS 420 Cover Crops in Agroecosystems	3
CSS 441 Plant Breeding and Biotechnology	3
CSS 442 Agroecology Ecology	3
CSS 467 Bioenergy Feedstock Production	3
CSS 470 Soil Resources	3

MINOR IN APPLIED DEVELOPMENT IN INTERNATIONAL AGRICULTURE AND NATURAL RESOURCES

This minor is available as an elective to students who are enrolled in bachelor's degree programs and is designed for students who have an interest in applied development in international agriculture and natural resources. It seeks to increase student understanding of global agriculture, particular agriculture-related problems and issues in developing and developed nations, and issues related to sustainability and stewardship of the Earth. Students who complete this minor will gain knowledge and experience relevant for careers in international agriculture, international development, and related fields.

The College of Agriculture and Natural Resources and James Madison College in cooperation with the Departments of Agricultural, Food, and Resource Economics, Animal Science, Food Science and Human Nutrition, Plant, Soil and Microbial Sciences, and Fisheries and Wildlife, and the College of Social Science in cooperation with the Department of Geography participate in the Minor in Applied Development in International Agriculture and Natural Resources. The Department of Plant, Soil and Microbial Sciences is the primary administrative unit.

The student's program of study for the minor must be approved by the advisor of the Minor in the Department of Plant, Soil and Microbial Sciences or James Madison College in advance and in writing. With the approval of the department that administers the student's degree program, courses that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Minor in Applied Development in International Agriculture and Natural Resources

The student must meet the requirements specified below:

	CREDITS
Complete a minimum of 17 credits from the following:	
1. Both of the following courses (5 credits):	
CSS 294 Issues in International Agriculture	1
MC 430 Applied International Development	4
2. One of the following courses (3 credits):	
ANS 480 Animal Systems in International Development	3
CSS 431 International Agricultural Systems	3
FW 481 Global Issues in Fisheries and Wildlife	3
ANS 480 may not be used to fulfill both this requirement and the Education Abroad requirement below.	
3. One of the following courses (3 or 4 credits):	
ABM 427 Global Agri-Food Industries and Markets	3
EEM 260 World Food, Population and Poverty	3
FW 445 Biodiversity Conservation Policy and Practice	3
GEO 410 Geography of Food and Agriculture	3
HNF 406 Global Foods and Culture	3
MC 320 Politics, Society, and Economy in the Third World	4
MC 450 International Environmental Law and Policy	3
4. Complete 3 credits in an Education Abroad, International Internship, or International Research Experience with approval by the advisor for the minor.	
5. Complete 3 or 4 credits in a foreign language, an additional Education Abroad, International Internship or International Research Experience, or additional elective course from items 2. and 3. above with approval by the advisor for the minor.	

MINOR IN ENVIRONMENTAL SOIL SCIENCE

The Minor in Environmental Soil Science is intended to serve students and professionals who plan to pursue careers in soil science, soil health, or related agricultural, natural resource, and environmental sciences with a focus on the sustainable management of soils to produce food, fiber, and other products while conserving or regenerating natural and managed ecosystems.

The requirements meet the soil science course work requirements for Federal and state employment as soil scientists, as well as the course work requirements necessary to become a Certified Professional Soil Scientist (CPSS).

At least 9 credits counted towards the requirements for this minor must be unique. Unique credits must not be used to fulfill another university, college, or major requirement in the student's program.

With the approval of the department and college that administer the student's degree program, 6 credits of course work that are used to satisfy the requirements for the minor may also be used to satisfy the requirements for the bachelor's degree.

Students who are interested in enrolling should contact an undergraduate advisor in the Department of Plant, Soil and Microbial Sciences.

Requirements for the Minor in Environmental Soil Science

Complete all of the following courses (15 credits):

			CREDITS
1. The following course (3 credits):			
CSS	210	Fundamentals of Soil Science	3
2. Complete 12 credits from the following, with a minimum of 6 credits from the Soil Science category:			
Soil Science			
CSS	203	World of Soils	2
CSS	330	Soil Chemistry	2
CSS	340	Applied Soil Physics	2
CSS	360	Soil Biology	2
CSS	470	Soil Resources	3
CSS	480	Soil Fertility and Management	3
Approved Electives			
ANS	418	Animal Agriculture and the Environment	3
CSS	411	Fire and Environmental Quality	3
CSS	420	Cover Crops in Agroecosystems	3
CSS	442	Agricultural Ecology	3
CSS	460	Plant-Microbe Interactions	3
CSS	488	Agricultural Cropping Systems: Integration and Problem Solving	3
CSUS	354	Water Resources Management	3
CSUS	453	Watershed Planning and Management	3
FOR	340	Forest Ecology	3
FOR	406	Applied Forest Ecology: Silviculture	3
FOR	413	Wildland Fire Ecology and Management	3
FW	410	Upland Ecology and Management	3
FW	416	Marine Ecology and Management	3
FW	417	Wetland Ecology and Management	3
FW	472	Limnology	3
GEO	221	Introduction to Geographic Information	3
GEO	306	Environmental Geomorphology	3
GEO	324	Remote Sensing of the Environment	4
GEO	325	Geographic Information Systems	3
GEO	402	Agricultural Climatology	3
GLG	411	Hydrogeology	3
GLG	412	Glacial Geology and the Record of Climate Change	4
GLG	431	Sedimentology and Stratigraphy	4
GLG	446	Ecosystems Modeling, Water and Food Security	3
HRT	332	Tree Fruit Production and Management	3
HRT	336	Viticulture and Berry Production	2
HRT	341	Vegetable Production and Management	3
PLB	402	Biology of Fungi	4
PLB	415	Plant Physiology	3
PLB	418	Plant Systematics	3
PLB	441	Plant Ecology	3

MINOR IN SUSTAINABLE AGRICULTURE AND FOOD SYSTEMS

The Minor in Sustainable Agriculture and Food Systems is designed to foster active learning about agriculture and food systems for undergraduate students from different disciplinary backgrounds. Contemporary agriculture and food systems issues will be considered in biological, ecological, social, and economic contexts.

The minor is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University. With the approval of the department and college that administers 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. The student's program of study must be approved by the Department of Plant, Soil and Microbial Sciences in advance and in writing.

Requirements for the Minor in Sustainable Agriculture and Food Systems

			CREDITS
The student must complete 15 credits from the following:			
1. All of the following courses (6 credits):			
CSS	124	Introduction Sustainable Agriculture and Food Systems	2
CSS	224	Sustainable Farm and Food Systems Field Studies	1
CSS	424	Sustainable Agriculture and Food Systems: Integration and Synthesis	3
2. One or two of the following courses (3 to 6 credits):			
Agricultural Sciences			
CSS	101	Introduction to Crop Science	3
CSS	360	Soil Biology	3
CSS	431	International Agricultural Systems	3
CSS	442	Agricultural Ecology	3
ENT	479	Organic Pest Management (W)	3
HNF	150	Introduction to Human Nutrition	3
HRT	203	Principles of Horticulture	3
HRT	251	Organic Farming Principles and Practices	3
HRT	341	Vegetable Production and Management	3
HRT	486	Biotechnology in Agriculture: Applications and Ethical Issues	3
3. One or two of the following courses (3 to 6 credits):			
Social Sciences			
ABM	400	Public Policy Issues in the Agri-Food System	3
CSUS	343	Community Food and Agricultural Systems	3
EEP	255	Ecological Economics	3
EEP	260	World Food, Population and Poverty	3
GEO	410	Geography of Food and Agriculture	3
HNF	406	Global Foods and Culture	3
RCAH	292B	Engagement and Reflection	3

MINOR IN TURFGRASS MANAGEMENT

The Minor in Turfgrass Management, administered by the Department of Plant, Soil and Microbial Sciences, is designed to serve students that plan to work in the landscape, recreational, or the sports management industry. Students will gain an understanding of the fundamentals of maintaining a turfgrass-playing surface or the turfgrass within a lawn or landscape.

The minor is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University. 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.

Students who plan to complete the requirements of the minor should consult the undergraduate advisor in the Department of Plant, Soil and Microbial Sciences to have their program of study approved in advance.

Requirements for the Minor in Turfgrass Management

Complete a minimum of 15 credits from the following:

		CREDITS
1. All of the following courses (8 credits):		
CSS 210	Fundamentals of Soil Science	3
CSS 232	Turfgrass Management	4
CSS 262	Turfgrass Management Seminar	1
2. One course from each of the following areas (a minimum of 7 credits):		
Management of Turfgrass Cultural Practices		
CSS 178	Turfgrass Irrigation	3
CSS 267	Performance Turf Design and Construction	2
CSS 272	Turfgrass Soil Fertility	2
CSS 282	Turfgrass Physiology	2
Management of Turfgrass Pests		
CSS 181	Pesticide and Fertilizer Application Technology	3
CSS 326	Weed Science	2
and		
CSS 226L	Weed Science Laboratory	1
ENT 264	Turfgrass Entomology	3
PLP 266	Turf Pathology	3
General Turfgrass Management		
CSS 171	Operations Budgeting for Golf Course Managers	2
CSS 202	World of Turf	2
HRT 214	Landscape and Turfgrass Business Operations	2

GRADUATE STUDY

The Department of Plant, Soil and Microbial Sciences offers programs leading to Master of Science and Doctor of Philosophy degrees in crop and soil sciences, global plant breeding, plant breeding, genetics and biotechnology—crop and soil sciences, and in plant pathology.

Students enrolled in the Doctor of Philosophy degree program may elect a Specialization in Biotechnology. For additional information, refer to the statement on the specialization.

CROP AND SOIL SCIENCES

Crop and soil science graduate students may study in one or more emphasis areas, including plant breeding and genetics; crop physiology, ecology, and management; weed science; turfgrass management; soil genesis and classification; soil microbiology and biochemistry; soil physics; soil chemistry; soil biophysics; soil fertility; and environmental and pollution aspects of soil science, including the study of waste disposal on land. Graduate programs of study are designed to reflect the individual needs and interests of students.

Master of Science

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Regular admission may be granted to students who have a bachelor's degree or its equivalent, a 3.00 grade-point average, and appropriate training in the biological and physical sciences and mathematics. Provisional admission may be granted to students who do not meet the requirements for regular admission. Students with deficiencies in their backgrounds will be required to complete collateral courses in addition to the courses that are required for the master's degree. Collateral course work does not count towards the degree requirements.

Requirements for the Master of Science Degree in Crop and Soil Sciences

The student may elect either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under either Plan A or Plan B. The student's program of study is planned in consultation with the guidance committee, which includes the major professor.

Requirements for Plan A and Plan B

		CREDITS
1. One of the following writing courses:		
CSS 880	Scientific Communication and Professional Development	1
ENT 812	Graduate Seminar	1
HRT 860	Scientific Writing: Workshop	1

2. Acquire experience in either (a) teaching, by serving as a teaching assistant in a course, or (b) extension through the development and delivery of outreach programs or materials, as approved by the guidance committee.
3. Complete the responsible conduct of research training.

Additional Requirements for Plan A

1. Complete 6 to 10 credits of CSS 899 Master's Thesis Research.
2. Complete a written thesis and present the results publicly at a departmental seminar prior to graduation.
3. Pass an oral examination before the guidance committee immediately after the public seminar at which the thesis results are presented.

Additional Requirements for Plan B

1. Complete a project through enrollment of up to 6 credits in CSS 890 and present the results publicly at a departmental seminar prior to graduation.
2. Pass an oral examination before the guidance committee immediately after the public seminar at which the project results are presented.

Doctor of Philosophy

Students are encouraged to take courses that provide a broad background in biological and physical sciences in addition to training in specialized areas. The doctoral program aims to provide a high-quality crop and soil science experience to equip students with the skills necessary for research, teaching, and extension, or other agriculture-related positions that require the Doctor of Philosophy degree.

In addition to meeting the requirements of the university and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Regular admission may be granted to students who have a master's degree or its equivalent, a 3.00 grade-point average, and appropriate training in the biological and physical sciences and mathematics. Outstanding students without a master's degree may be accepted. Provisional

admission may be granted to students who do not meet the requirements for regular admission. Students with deficiencies in their backgrounds will be required to complete collateral courses in addition to the courses that are required for the master's degree. Collateral course work does not count towards the degree requirements.

Requirements for the Doctor of Philosophy Degree in Crop and Soil Sciences

All doctoral students must plan their degree program in consultation with the guidance committee and their major professor and must meet the requirements specified below:

1. Complete at least 24 credits including one of the following writing courses: (CREDITS)
   - CSS 880 Scientific Communication and Professional Development 1
   - ENT 812 Graduate Seminar 1
   - HRT 860 Scientific Writing: Workshop 1
2. Acquire experience in either (a) teaching, by serving as a teaching assistant in a course, or (b) extension through the development and delivery of outreach programs or materials, as approved by the guidance committee.
3. Complete the responsible conduct of research training.
4. Complete 24 credits of CSS 999 Doctoral Dissertation Research.
5. Complete a written dissertation proposal and present its results publicly at a departmental seminar prior to graduation.
6. Presentation of at least one oral seminar on the dissertation research at a professional meeting.
7. Complete oral and written comprehensive examinations.
8. Pass a final oral examination in defense of the dissertation before the guidance committee immediately after the public seminar at which the dissertation results are presented.

GLOBAL PLANT BREEDING

Master of Science

The Master of Science Degree in Global Plant Breeding provides opportunities for working professionals to obtain new knowledge in laws and regulations, design thinking and leadership, and global seed systems.

In addition to meeting the requirements of the University and of the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

The student must:

1. have earned a bachelor’s degree with a grade-point average of 3.0;
2. provide all undergraduate transcripts;
3. provide three letters of recommendation;
4. provide a personal statement describing the applicants interest and experience in plant breeding and their personal career goals;
5. provide a resume or test scores from a standardized graduate or professional school test such as the GRE, GMAT, MCAT, DAT, or LSAT, which may be waived if the applicant has a previously conferred graduate or professional degree;
6. provide test scores from an English proficiency examination if from non-English speaking country;
7. have completed at least one college level introductory course in Advanced Mathematics, Biology, and Genetics;
8. have completed 15 undergraduate credit hours in plant science course work.

Guidance Committee

The Global Plant Breeding Committee is composed of the director of the Global Plant Breeding program and two additional regular MSU faculty members.

Requirements for the Master of Science Degree in Global Plant Breeding

A minimum of 30 credits is required for the degree under Plan B (without thesis). The program is available only online.

1. Complete all of the following courses (24 credits): (CREDITS)
   - CSS 441 Plant Breeding and Biotechnology 3
   - CSS 451 Biotechnology Applications for Plant Breeding and Genetics 3
   - CSS 815 Statistics for Plant Breeders 3
   - CSS 816 R Modules for Plant Breeders 2
   - CSS 817 Global Plant Breeding Regulations 2
   - CSS 818 Design Thinking and Leadership for Plant Breeders 2
   - CSS 830 Breeding for Quantitative Traits 3
   - CSS 831 Breeding for Biotic and Abiotic Stresses 3
   - CSS 832 Global Seed Systems 3
2. Complete both of the following courses (6 credits):
   - CSS 870 Capstone in Global Plant Breeding 3
   - CSS 890 Independent Study 3
3. Complete training in Responsible Conduct of Research (RCR)
4. Successfully pass a final oral evaluation in defense of a final professional breeding project.

PLANT BREEDING, GENETICS and BIOTECHNOLOGY—CROP and SOIL SCIENCES

The Department of Plant, Soil and Microbial Sciences offers Master of Science and Doctor of Philosophy degree programs in plant breeding, genetics and biotechnology–crop and soil sciences. The requirements for admission and the requirements for the degree are specified in the statement on *Interdepartmental Graduate Programs in Plant Breeding, Genetics and Biotechnology*.

PLANT PATHOLOGY

Plant pathology graduate students may study in one or more emphasis areas, including Phyto bacteriology, mycology, virology, epidemiology, host parasite interactions, soil microbiology, disease management and molecular biology. Commodity-oriented strategic research areas in which the above emphasis areas may be studied include vegetable crops, fruit crops, nursery, landscape and ornamentals, field crops, turf crops, and forest and tree pathology. Students are encouraged to take courses which provide a broad background in biological and physical sciences in addition to training in specialized areas.

Master of Science

In addition to meeting the requirements of the university and the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Regular admission may be granted to those students who have a bachelor's degree or its equivalent, a 3.00 grade point average, and appropriate training in the biological and physical sciences and mathematics.

Provisional admission may be granted to those students who do not meet the requirements for regular admission. Students with deficiencies in their backgrounds will be required to complete collateral courses in addition to the courses that are required for the master's degree. Collateral course work does not count towards the degree requirements.

Requirements for the Master of Science Degree in Plant Pathology

The student may elect either Plan A (with thesis) or Plan B (without thesis). A total of 30 credits is required for the degree under either Plan A or Plan B. The student's program of study is planned in consultation with the guidance committee, which includes the major professor.

Requirements for Plan A and Plan B

			CREDITS
1. Both of the following courses (3 credits):			
	PLP 894	Seminar in Plant Pathology	1
	PLP 805	Principles in Plant Pathology	2
2. Two of the following courses (7 or 8 credits):			
	PLP 847	Advanced Mycology	4
	or		
	PLB 402	Biology of Fungi	4
	PLP 884	Prokaryotic Diseases of Plants	3
	PLP 885	Plant Diseases in the Field	2
3. One of the following courses (3 credits):			
	PLP 812	Epidemiology of Plant Diseases	3
	PLP 850	Physiological Plant Pathology	3
	PLP 881	Molecular and Biochemical Plant Pathology	3

4. Acquire experience in either (a) teaching, by serving as a teaching assistant in a course or, (b) extension, through the development and delivery of outreach programs or materials, as approved by the guidance committee.
5. Other courses and/or reading knowledge of a foreign language as specified by the guidance committee.

Additional Requirements for Plan A

1. Complete 4 credits of PLP 899 Master's Thesis Research.
2. Complete a written thesis and present the result publicly at a departmental seminar prior to graduation.
3. Pass a final oral examination in defense of the thesis before the guidance committee which occurs immediately after the public seminar at which the thesis results are presented.

Additional Requirements for Plan B

1. Complete a project and present the result publicly at a departmental seminar prior to graduation.
2. Pass a final oral examination before the guidance committee which occurs immediately after the public seminar at which the project results are presented.

Doctor of Philosophy

The objective of this program is to provide a high quality plant pathology graduate experience to equip students with the skills necessary for research, teaching and extension, or other agriculture-related positions that require the Doctor of Philosophy degree.

In addition to meeting the requirements of the university and the College of Agriculture and Natural Resources, students must meet the requirements specified below.

Admission

Regular admission may be granted to those students having a master's degree or its equivalent, a 3.00 grade point average, and appropriate training in the biological and physical sciences and mathematics. Outstanding students without a master's degree may be accepted.

Provisional admission may be granted to those students who do not meet the requirements for regular admission.

Requirements for the Doctor of Philosophy Degree in Plant Pathology

All doctoral students in plant pathology must meet the requirements specified below:

1. Pass a preliminary examination.
2. Acquire experience in either (a) teaching, by serving as a teaching assistant in a course or, (b) extension, through the development and delivery of outreach programs or materials, as approved by the guidance committee.
3. Complete all of the following courses:

PLP	805	Principles of Plant Diseases	3
PLP	812	Epidemiology of Plant Diseases	3
PLP	847	Advanced Mycology	4
or			
PLB	402	Biology of Fungi	4
PLP	850	Physiological Plant Pathology	3
PLP	881	Molecular and Biochemical Plant Pathology	3
PLP	884	Prokaryotic Diseases of Plants	3
PLP	885	Plant Diseases in the Field	2
PLP	894	Seminar in Plant Pathology	3
PLP	999	Doctoral Dissertation Research	24

Students who completed 2 credits of PLP 894 at MSU as a master's student must complete 3 additional credits of PLP 894.

4. Other courses and/or reading knowledge of a foreign language as specified by the guidance committee.
5. Complete oral and written comprehensive examinations.
6. Complete a written thesis and present the result publicly at a departmental seminar prior to graduation.
7. Pass an oral examination in defense of the thesis before the guidance committee which occurs immediately after the public seminar at which the thesis results are presented.

GRADUATE SPECIALIZATION IN SUSTAINABLE AGRICULTURE AND FOOD SYSTEMS

The Graduate Specialization in Sustainable Agriculture and Food Systems is designed to foster an understanding of biogeochemical, socioeconomic, and policy concepts using experiential learning within the individual's program of study as a venue for multidisciplinary work. For global perspectives, students are encouraged to participate in either a study abroad course with ecological food and farming systems content, or in a course with international focus.

The specialization is available as an elective to students who are enrolled in master's or doctoral degree programs at Michigan State University. With the approval of the department and college that administers the student's degree program, the courses that are used to satisfy the specialization may also be used to satisfy the requirements for the master's or doctoral degree. The student's program of

study must be approved by the advisor for the specialization in the Department of Plant, Soil and Microbial Sciences in advance and in writing.

Requirements for the Graduate Specialization in Sustainable Agriculture and Food Systems

			CREDITS
The student must complete 9 credits from the following:			
1. Both of the following courses (3 credits):			
CSS	824	Sustainable Agriculture and Food Systems Field Practicum	2
CSS	826	Sustainable Agriculture and Food Systems Capstone Seminar	1
2. One of the following courses (3 credits):			
CSS	424	Sustainable Agriculture and Food Systems: Integration and Synthesis	3
CSS	431	International Agricultural Systems	3
CSS	442	Agricultural Ecology	3
CSS	893	Special Topics	3
ENT	479	Organic Pest Management (W)	3
ENT	848	Biological Control of Insects and Weeds	3
HRT	486	Biotechnology in Agriculture: Applications and Ethical Issues	3
3. One of the following courses (3 credits):			
AFRE	400	Public Policy Issues in the Agri-Food System	3
AFRE	861	Agriculture in Economic Development	3
CSUS	463	Food Fight: Politics of Food	3
CSUS	811	Community, Food and Agriculture: A Survey	3
CSUS	838	Participatory Modes of Inquiry	3
CSUS	848	Community Based Natural Resource Management In International Development	3
CSUS	855	Political Ecology of Food	3
CSUS	858	Gender Justice and Environmental Change: Issues and Concepts	3
GEO	410	Geography of Food and Agriculture	3
HNF	406	Global Foods and Culture	3

DEPARTMENT of PLANT BIOLOGY

Andrea Case, Chairperson

The Department of Plant Biology is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science. Plant Biology is the branch of natural science that deals with all aspects of the biology of plants, encompassing all levels of biological organization from molecules to the ecosystem. Plant biology concerns itself with the study of the structure, function, evolution, physiology, molecular biology, biochemistry, genetics, and systematics of all taxonomic groups of plants and fungi. Plant biology is central to the wide divergence of disciplines that make up modern plant science at Michigan State University and deals with the relationships between plants and society. Students in this program can study all aspects of plant biology and they are trained to integrate information between different hierarchies of biological organization while at the same time developing a deep understanding of their area of specialization.

The department offers Master of Science and Doctor of Philosophy degree programs with majors in plant breeding, genetics and biotechnology–plant biology through the College of Agriculture and Natural Resources. Those programs are referenced below. The department also offers Master of Science and Doctor of Philosophy degree programs with majors in plant biology through the College of Natural Science. For information about those programs, refer to the statement on the *Department of Plant Biology* in the *College of Natural Science* section of this catalog.

PLANT BREEDING, GENETICS and BIOTECHNOLOGY–PLANT BIOLOGY

The Department of Plant Biology offers Master of Science and Doctor of Philosophy degree programs in plant breeding, genetics and biotechnology–plant biology. The requirements for admission and the requirements for the degree are specified in the statement on *Interdepartmental Graduate Programs in Plant Breeding, Genetics and Biotechnology*.

INSTITUTE of AGRICULTURAL TECHNOLOGY

The Institute of Agricultural Technology (IAT) empowers students to succeed in the diverse industries within the agricultural sector, from farming to food processing to forestry. We offer various certificate programs across multiple locations statewide through partnerships with community colleges and industry leaders. With a practical, career-focused program structure, most IAT students complete their certificates in 3-4 academic semesters. Courses are taught by experienced faculty and industry professionals approved by the university. With more than a century of experience, MSU IAT is committed to propelling agricultural and environmental stewards toward a more innovative, sustainable future. Details about the requirements for each certificate program can be found in the Programs section below.

PROGRAMS

Agricultural Industries

The Agricultural Industries program provides students with in-depth agricultural industry expertise paired with essential business knowledge. Students can apply this knowledge to their own operations or for launching a career in various agricultural sectors. Through both on-campus learning and hands-on experiences, courses provide a background in crop and soil sciences along with agribusiness management. Upon completion of the program, students are often recruited by agricultural businesses within their chosen focus areas or are prepared to lead their own successful organizations. Some common career paths include crop production management; agricultural retail management; agricultural sales (such as seed, fertilizer, chemicals or feed); and crop and agricultural processing or manufacturing.

Requirements for Agricultural Industries

			CREDITS
The student must complete 48 credits from the following:			
1. All of the following courses (28 to 31 credits):			
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	130	Farm Management I	3
AT	045	Agricultural Communications	2
AT	055	Agricultural Finance	3
AT	071	Technical Mathematics	2
AT	293	Professional Internship in Agricultural Technology	3 to 6
AT	214	Leadership Development in Agriculture and Natural Resources Industries	2
CSS	101	Introduction to Crop Science	3
CSS	101L	Introduction to Crop Science Laboratory	1
CSS	110	Computer Applications in Agronomy	2
CSS	126	Introduction to Weed Management	2
CSS	192	Professional Development Seminar I	1
CSS	226L	Weed Science Laboratory	1
2. Two of the following courses (4 to 6 credits):			
CSS	120	Issues in Food and Agriculture	3
CSS	135	Crop Scouting and Investigation	3
CSS	151	Seed and Grain Quality	2
CSS	201	Forage Crops	3
CSS	212	Advanced Crop Production	2
CSS	222	New Horizons in Biotechnology	2
3. One of the following courses (3 credits):			
AFRE	222	Agribusiness and Food Industry Sales	3
AFRE	232	Commodity Marketing I	3
4. One of the following courses (2 or 3 credits):			
CSS	203	World of Soils	2
CSS	210	Fundamentals of Soil Science	3
5. Complete a minimum of 5 to 11 elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.			

Agricultural Operations

The Agricultural Operations program provides students with a comprehensive education in the fundamental principles soil science, precision agriculture, water management, entomology, plant pathology and business management. Through hands-on training and experiential learning opportunities such as field laboratories and internships, students gain the practical skills and knowledge needed to succeed in various sectors of the agricultural industry. Students have the option to choose their own specialization within a broad curriculum. Upon completion of the program, graduates achieve successful careers in areas such as equipment retail sales and service; farm operations; crop production management; production service; and crop processing.

Requirements for Agricultural Operations

			CREDITS
Students must complete 60 credits from the following:			
1. All of the following courses (28 credits):			
AFRE	130	Farm Management I	3
AE	131	Agricultural Water Resource Management	3
AE	143	Application of Precision Agriculture Technologies	3
AT	100	Career Development in Agricultural Technology	1
AT	202	Agricultural Regulation, Compliance and Safety	3
AT	293	Professional Internship in Agricultural Technology	3
CSS	101	Introduction to Crop Science	3
CSS	126	Introduction to Weed Management	2
CSS	203	World of Soils	2
ENT	110	Applied Entomology of Economic Plants	3
PLP	105	Fundamentals of Applied Plant Pathology	1
PLP	105L	Fundamentals of Applied Plant Pathology Lab	1
2. Complete a minimum of 6 elective credits in the College of Agriculture and Natural Resources as approved by the program coordinator in the Institute of Agricultural Technology.			
3. Complete 26 credits of additional course work through the College of Agriculture and Natural Resources, a community college partner (Bay College, Delta, College, Glen Oaks Community College, Kellogg Community College, Monroe Community College, Montcalm Community College, Muskegon Community College, Southwestern Michigan College, West Shore Community College) or an approved transferring institution. All course work must be approved by the program coordinator in the Institute of Agricultural Technology. Students at Muskegon Community College are required to complete 28 additional credits of course work.			

Dairy Management

The Dairy Management program provides students with a foundation of knowledge and practical skills regarding dairy cows, the dairy industry and dairy farming as a business. Courses are relevant to the modern dairy industry's trends by focusing on skills needed to be a successful dairy farm owner, herdsperson or employee. Upon completion of the program, graduates often follow successful career paths in dairy farm management; dairy feed management; dairy herd reproduction; dairy health management; and dairy genetics.

Requirements for Dairy Management

			CREDITS
The student must complete 48 credits from the following:			
1. All of the following courses (35 credits):			
ANS	132	Dairy Farm Management Seminar	2
ANS	134	Dairy Production I	3
ANS	200C	Dairy Cattle Genetics and Evaluation	2
ANS	203	Principles of Livestock Feeding	2
ANS	233	Dairy Feed Management	3
ANS	234	Dairy Production II	3
ANS	235	Dairy Herd Reproduction	2
ANS	235L	Dairy Herd Reproduction Laboratory	2
ANS	238	Dairy Cattle Health Management	3
ANS	295	Structure and Function of Livestock	2
AT	045	Agricultural Communications	2
AT	071	Technical Mathematics	2
AT	101	Spanish for the Agricultural Industry	2
AT	293	Professional Internship in Agricultural Technology	3
CSS	110	Computer Applications in Agronomy	2
2. Complete a minimum of 13 credits of course work in the college from the following as approved by the program coordinator in the Institute of Agricultural Technology:			
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	130	Farm Management I	3
AFRE	232	Commodity Marketing I	3
ANS	110	Introductory Animal Agriculture	3
ANS	110L	Introductory Animal Agriculture Laboratory	1
ANS	222	Introductory Beef Cattle Management	3
AT	055	Agricultural Finance	3
CSS	101	Introduction to Crop Science	3
CSS	101L	Introduction to Crop Science Laboratory	1
CSS	120	Issues in Food and Agriculture	3
CSS	201	Forage Crops	3
CSS	212	Advanced Crop Production	2

Electrical Technology

The Electrical Technology program provides electrical apprenticeship training with an emphasis on residential, agricultural, commercial and industrial wiring. Students study the latest electrical fundamentals, codes, various installations, motor controls and solid-state electronic applications, as well as energy efficiency and alternate power systems. This program is recognized by the U.S. Department of Labor, Bureau of Apprenticeship and Training, and the State of Michigan Bureau of Construction Codes. Upon completion of the program, graduates often achieve

successful careers as manufacturing facilities managers; alternate energy installers; electrical inspectors; State government electricians; electrical contractors; or equipment service personnel.

Requirements for Electrical Technology

Students must complete 48 credits from the following: CREDITS

1. All of the following courses (38 credits):
   - AE 102 Electrical Lighting for Residential and Agricultural Facilities 2
   - AE 172 Electrical Wiring I 4
   - AE 173 Electrical Occupations 1
   - AE 182 Electrical Wiring II 3
   - AE 185 Electrical Applications 3
   - AE 192 Electrical Wiring III 4
   - AE 194 Electrical Systems Planning 4
   - AT 045 Agricultural Communications 2
   - AT 071 Technical Mathematics 2
   - AT 293 Professional Internship in Agricultural Technology 3
   - TSM 121 Fundamentals of Electricity 4
   - TSM 130 Energy Efficiency and Conservation in Agricultural Systems 3
   - TSM 222 Fundamentals of Automation and Controls 3

   Students who demonstrate proficiency through placement testing for AT 045 and AT 071 can take elective course work to substitute the credit in those courses as approved by the program coordinator.
2. The following course or equivalent certification:
   - KIN 125 First Aid and Personal Safety 3

   Equivalent certification is current first aid and CPR certification.
3. Complete a minimum of 7 credits of additional Agricultural Technology courses chosen in consultation with and approved by the program coordinator.

Food Processing, Technology and Safety

The Food Processing, Technology and Safety program provides students with hands-on education in the processes and technologies used to convert commodities into consumable food products. Students are able to personalize their curriculum from various areas of study, from food processing and technology, to facilities management, to chemistry. The program incorporates applied learning experiences within a mobile food processing lab and industry internships. Upon completion of the program, graduates go on to follow successful career paths in areas such as raw ingredient manufacturing; food technology; food safety; food machinery and equipment maintenance; and specialty food processing.

Requirements for Food Processing, Technology and Safety

Students must complete 60 credits from the following: CREDITS

1. All of the following courses (27 credits):
   - AFRE 100 Decision-making in the Agri-Food System 3
   - AT 193 Agricultural Technology Clerkship 2
   - AT 293 Professional Internship in Agricultural Technology 3
   - FSC 111 Foundational Concepts in Food Processing and Technology 3
   - FSC 112 Seminar in Food Processing, Technology and Safety 1
   - FSC 113 Basic Commodity Overview Food Processing and Technology 3
   - FSC 114 Food Processing and Technology Facilities Management 3
   - FSC 125 Food Processing and Technology Unit Operations 2
   - FSC 240 Applied Microbiology in Food Processing 2
   - FSC 241 Safety Principles and Regulations in Food Processing and Technology 3
   - FSC 242 Applied Chemistry in Food Processing and Technology 2
2. Two of the following courses (4 credits):
   - FSC 230 Fruit and Vegetable Processing 2
   - FSC 231 Cereals Processing 2
   - FSC 232 Dairy Foods Processing 2
   - FSC 233 Muscle Foods Processing 2
3. Complete a minimum of 3 elective credits in the College of Agriculture and Natural Resources as approved by the program coordinator in the Institute of Agricultural Technology.
4. Complete 26 credits of additional course work through the College of Agriculture and Natural Resources, a community college partner (Delta College, Kellogg Community College, Muskegon Community College, Wayne County Community College District) or an approved transferring institution. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Forest Technology

The Forest Technology program provides students with the competencies and technical skills necessary to sustainably manage forested systems in Michigan and beyond. Through internships and networking opportunities, students connect with local forestry experts and employers to gain hands-on experience. The program's curriculum incorporates a variety of in demand skills, such as tree identification and forest inventory, forest ecology and silviculture, wildland firefighting and timber harvest operations. Upon completion of the program, graduates are often in high demand by a variety of industry and agency employers, and go on to achieve careers as forest technicians; procurement foresters; consultants; wildland firefighters; and land surveyors.

Requirements for Forest Technology

Students must complete 63 credits from the following:

1. All of the following courses (33 courses):
   - AT 293 Professional Internship in Agricultural Technology 3
   - CSS 143 Introduction to Soil Science 2
   - ENT 110 Applied Entomology of Economic Plants 3
   - FOR 115 Field Exploration of Topics in Forest Technology 1
   - FOR 116 Career Development in Forestry Technology 1
   - FOR 117 Natural Resources Equipment and Worker Safety 1
   - FOR 130 Fundamentals of Forest Management Planning 1
   - FOR 135 Forest Issues and Policy 1
   - FOR 204 Forest Vegetation 3
   - FOR 222 Forestry Field Methods 2
   - FOR 250 Introduction to Forest Ecology and Silviculture 3
   - FOR 260 Applied Forest Management 3
   - FOR 265 Crew Leadership and Management of Forest Technology 2
   - FOR 270 Forest Business Operations 2
   - FOR 275 Timber Harvest Planning and Systems 3
   - PLP 105 Fundamentals of Applied Plant Pathology 2
2. Complete 30 credits of additional course work through Bay College. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Fruit and Vegetable Crop Management

The Fruit and Vegetable Crop Management program provides students with practical knowledge and training regarding the selection, use and management of fruit and vegetable crops. The program blends hands-on experiences like field laboratories and internships with curriculum across a variety of focus areas, such as farm management, agricultural compliance and safety, soil science, plant pathology and irrigation systems. Upon completion of the program, graduates often lead successful careers in

horticultural, farming and crop production industries, with roles across farming operations, crop production and management, urban farming and greenhouse production.

Requirements for Fruit and Vegetable Crop Management

Students must complete 48 credits from the following:

1. All of the following courses (22 credits):

			CREDITS
AFRE	130	Farm Management I	3
AT	202	Agricultural Regulation Compliance and Safety	3
AT	293	Professional Internship in Agricultural Technology	3
CSS	126	Introduction to Weed Management	2
CSS	203	World of Soils	2
ENT	110	Applied Entomology of Economic Plants	3
HRT	206	Training and Pruning Plants	1
HRT	207	Horticulture Career Development	1
HRT	218	Irrigation Systems for Horticulture	2
PLP	105	Fundamentals of Applied Plant Pathology	1
PLP	105L	Fundamentals of Applied Plant Pathology Lab	1

2. Complete a minimum of 3 elective credits in the College of Agriculture and Natural Resources as approved by the program coordinator in the Institute of Agricultural Technology.
3. Complete 23 credits of additional course work through the College of Agriculture and Natural Resources, a community college partner (Muskegon Community College, Northwestern Michigan College, Southwestern Michigan College, Wayne County Community College District, West Shore Community College) or an approved transferring institution. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Fruit, Vegetable, and Organic Horticulture Management

The Fruit, Vegetable and Organic Horticulture Management program provides students with hands-on skills needed to thrive in the fruit and vegetable industries. Core courses lay the foundational principles in horticulture, soils, entomology and plant pathology. From there, students tailor their studies with courses in agribusiness, fruit and vegetable production, organic farming practices, greenhouse management and more. Upon completion of the program, graduates often lead careers in food crop industries; fruit and vegetable production; urban farming; organic farms and community-supported agriculture programs; greenhouse and controlled environment crop production; farmers' markets; and irrigation installation and management.

Requirements for Fruit, Vegetable, and Organic Horticulture Management

Students must complete 48 credits from the following:

1. All of the following courses (23 credits):

			CREDITS
AT	293	Professional Internship in Agricultural Technology	3
CSS	110	Computer Applications in Agronomy	2
CSS	210	Fundamentals of Soil Science	3
ENT	111	Basics of Applied Entomology	2
HRT	109	Introduction to Applied Plant Science	2
HRT	203	Introduction to Horticulture	3
HRT	204	Plant Propagation and Use	3
HRT	207	Horticulture Career Development	1
HRT	218	Irrigation Systems for Horticulture	2
PLP	105	Fundamentals of Applied Plant Pathology	1
PLP	105L	Fundamentals of Applied Plant Pathology Lab	1

2. A minimum of 15 credits from the following courses:

AE	151	Fabrication Technology	2
AE	153	Engine and Equipment Technology	2
AFRE	100	Decision-making in the Agri-Food System	3
AFRE	130	Farm Management I	3
AFRE	222	Agribusiness and Food Industry Sales	3
AT	101	Spanish for the Agricultural Industry	2
AT	202	Agricultural Regulation, Compliance and Safety	3
CSS	124	Introduction to Sustainable Agriculture and Food Systems	2
CSS	126	Introduction to Weed Management	2
CSS	135	Crop Scouting and Investigation	3
CSS	226L	Weed Science Laboratory	1
HRT	218L	Irrigation Systems for Horticulture Laboratory	1
HRT	242	Passive Solar Greenhouses for Protected Cultivation	1
HRT	243	Organic Transplant Production	1
HRT	251	Organic Farming Principles and Practices	3
HRT	253	Compost Production and Use	1

3. Completion of 10 additional elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.

Students who do not demonstrate English proficiency through the IAT administered placement test or college-level transfer credit must complete AT 045 Agricultural Communications (2 credits) or an equivalent course as approved by the program coordinator.

Students who do not demonstrate math proficiency through the IAT-administered placement test or college-level transfer credit must complete AT 071 Technical Mathematics (2 credits) or an equivalent course as approved by the program coordinator.

Landscape and Nursery Management

The Landscape and Nursery Management program provides students with hands-on knowledge regarding the production, selection, use and management of landscape plants. Students can personalize their learning with specialized focus areas, such as plant identification, soil sciences, pest management, irrigation design and more. Upon completion of the program, graduates often begin successful careers in expanding horticultural industries, such as landscape design, construction and management; nursery and greenhouse management; garden center management and sales; public gardens and arboreta; and urban tree care.

Requirements for Landscape and Nursery Management

Students must complete 48 credits from the following:

1. All of the following courses (31 credits):

			CREDITS
AT	102	Turf and Landscape Analytical Practices	2
AT	293	Professional Internship in Agricultural Technology	3
CSS	110	Computer Applications in Agronomy	2
CSS	210	Fundamentals of Soil Science	3
ENT	111	Basics of Applied Entomology	2
HRT	109	Introduction to Applied Plant Science	2
HRT	207	Horticulture Career Development	1
HRT	211	Landscape Plants I	3
HRT	212	Landscape Plants II	3
HRT	213	Landscape Maintenance	2
HRT	213L	Landscape Maintenance Field Laboratory	1
HRT	214	Landscape and Turfgrass Business Operations	2
HRT	218	Irrigation Systems for Horticulture	2
HRT	218L	Irrigation Systems for Horticulture Laboratory	1
PLP	105	Fundamentals of Applied Plant Pathology	1
PLP	105L	Fundamentals of Applied Plant Pathology Lab	1

2. Complete a minimum of 8 credits from the following:

AE	151	Fabrication Technology	2
AE	153	Engine and Equipment Technology	2
AT	101	Spanish for the Agricultural Industry	2
AT	202	Agricultural Regulation, Compliance and Safety	3
CSS	126	Introduction to Weed Management	2
CSS	181	Pesticide and Fertilizer Application Technology	3
CSS	202	World of Turf	2
CSS	226L	Weed Science Laboratory	1
HRT	203	Introduction to Horticulture	3

3. Complete 9 additional elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.

Students who do not demonstrate English proficiency through the IAT-administered placement test or college-level transfer credit must complete AT

045 Agricultural Communications (2 credits) or an equivalent course as approved by the program coordinator.

Landscape Management

The Landscape Management program provides students with practical knowledge and training regarding the selection, use and management of landscape plants and lawns. Students explore plant growth, development and identification, with areas of study in soil science, landscape maintenance, irrigation, weed management and more. Upon completion of the program, graduates are prepared for careers in the green industry such as landscape design, construction and management; irrigation systems; retail equipment and supply centers; greenhouse and field nursery operations; professional lawn services; and retail garden centers.

Requirements for Landscape Management

Students must complete 48 credits from the following: CREDITS

1. All of the following courses (26 credits):
   - AT 202 Agricultural Regulation, Compliance and Safety 3
   - AT 293 Professional Internship in Agricultural Technology 3
   - CSS 126 Introduction to Weed Management 2
   - CSS 203 World of Soils 2
   - ENT 110 Applied Entomology of Economic Plants 3
   - HRT 207 Horticulture Career Development 1
   - HRT 211 Landscape Plants I 3
   - HRT 212 Landscape Plants II 3
   - HRT 213 Landscape Maintenance 2
   - HRT 218 Irrigation Systems for Horticulture 2
   - PLP 105 Fundamentals of Applied Plant Pathology 1
   - PLP 105L Fundamentals of Applied Plant Pathology Lab 1
2. Complete 22 credits of additional course work through the College of Agriculture and Natural Resources, a community college partner (Muskegon Community College, Northwestern Michigan College, Wayne County Community College District) or an approved transferring institution. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Livestock Industries

The Livestock Industries certificate program is designed to give students a professional advantage in the livestock production career field of their choice. Students are exposed to a broad spectrum of applied course work and hands-on education at the university's facilities and an extensive industry internship. Students engage with leading professors, researchers, and future professional colleagues in a manner that is directly applicable to a functioning livestock operation and also develop communication skills while bridging the gap between theory and practical best management practices.

Requirements for Livestock Industries

Students must complete 48 credits from the following: CREDITS

1. All of the following courses (27 credits):
   - AFRE130 Farm Management I 3
   - ANS 110 Introductory Animal Agriculture 3
   - ANS 110L Introductory Animal Agriculture Laboratory 1
   - ANS 111 Livestock Industries Seminar 1
   - ANS 201 Animal Products 3
   - ANS 203 Principles of Livestock Feeding 2
   - ANS 295 Structure and Function of Livestock 2
   - AT 045 Agricultural Communications 2
   - AT 071 Technical Mathematics 2
   - AT 293 Professional Internship in Agricultural Technology 3
   - CSS 101 Introduction to Crop Science 3
   - CSS 110 Computer Applications in Agronomy 2
2. One of the following Livestock Clerkships (2 or 3 credits):
   - ANS 115 Meat Technology Clerkship 3
   - ANS 122A Feedlot Clerkship 2
   - ANS 122B Beef Cow Calf Clerkship 2
   - ANS 151 Poultry Production Clerkship 2
   - ANS 162 Sheep Production Clerkship 2
   - ANS 171 Swine Clerkship 2
3. Two of the following Livestock Management courses (6 credits):
   - ANS 134 Dairy Production 1
   - ANS 222 Introductory Beef Cattle Management 3
   - ANS 252 Introduction to Management of Avian Species 3
   - ANS 262 Introductory Sheep Management 3
   - ANS 272 Introductory Swine Management 3
4. Complete 12 or 13 credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.

Turfgrass Management

The growing demand for recreational areas and rededication to the maintenance of green spaces in America has created a shortage of turfgrass specialists. With an international reputation in turfgrass research and education, we offer two pathways in turfgrass management—Golf Course Management or Sports and Commercial Turf Management.

The *Turfgrass Management – Golf Course* program provides students with a solid foundation in plant science along with the specific expertise and skills needed for a career in golf course supervision and management. This program offers students hands-on learning experiences across numerous areas of study, such as soil and landscape science, pest management and golf course design and construction. Previous work experience on a golf course maintenance crew is expected. Upon completion of the program, graduates often achieve successful careers at the more than 14,000 golf courses in the United States, as senior crew members; superintendents; professional groundskeepers; golf course managers; turf specialists; licensed irrigators; or sales and marketing professionals.

The *Sports and Commercial Turf Management* program provides students with a solid foundation of knowledge in turfgrass management as it pertains to sports beyond golf. This program offers students hands-on learning experiences across numerous areas of study, such as soil and landscape science, plant biology, pesticide and fertilizer technology, and performance turf design and construction. Upon completion of the program, graduates often achieve successful careers in sports and turf management, as professional baseball groundskeepers; football and soccer turf managers; turf specialists in lawn-care and landscape-maintenance companies; licensed irrigators; sod production managers; or sales and marketing professionals.

Requirements for the Golf Course Emphasis

Students must complete 54 credits from the following: CREDITS

1. All of the following courses (52 credits):
   - AE 153 Engine and Equipment Technology 2
   - AT 101 Spanish for the Agricultural Industry 2
   - AT 102 Turf and Landscape Analytical Practices 2
   - AT 293 Professional Internship in Agricultural Technology 3
   - CSS 110 Computer Applications in Agronomy 2
   - CSS 126 Introduction to Weed Management 2
   - CSS 171 Operations Budgeting for Golf Course Managers 2
   - CSS 178 Turfgrass Irrigation 3
   - CSS 181 Pesticide and Fertilizer Application Technology 3

CSS	210	Fundamentals of Soil Science	3
CSS	226L	Weed Science Laboratory	1
CSS	232	Turfgrass Management	4
CSS	262	Turfgrass Management Seminar	2
CSS	264	Golf Course Design and Construction Techniques	2
CSS	267	Performance Turf Design and Construction	2
CSS	269	Turfgrass Strategies: Integration and Synthesis	2
CSS	272	Turfgrass Soil Fertility	2
CSS	282	Turfgrass Physiology	2
ENT	364	Turfgrass Entomology	3
HRT	109	Introduction to Applied Plant Science	2
HRT	213	Landscape Maintenance	2
HRT	213L	Landscape Maintenance Field Laboratory	1
PLP	266	Turf Pathology	3

Students must enroll in two separate 1-credit sections of CSS 262.

2. Complete a minimum of 2 elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.

Students who do not demonstrate English proficiency through the IAT-administered Accuplacer placement test or college-level transfer credit must complete AT 045 Agricultural Communications (2 credits) or an equivalent course as approved by the program coordinator.

Sports and Commercial Turf Management Emphasis

Requirements for the Sports and Commercial Turf Management Emphasis

Students must complete 54 credits from the following:

1. All of the following courses (52 credits):

			CREDITS
AE	153	Engine and Equipment Technology	2
AT	101	Spanish for the Agricultural Industry	2
AT	102	Turf and Landscape Analytical Practices	2
AT	293	Professional Internship in Agricultural Technology	3
CSS	110	Computer Applications in Agronomy	2
CSS	126	Introduction to Weed Management	2
CSS	171	Operations Budgeting for Golf Course Managers	2
CSS	178	Turfgrass Irrigation	3
CSS	181	Pesticide and Fertilizer Application Technology	3
CSS	210	Fundamentals of Soil Science	3
CSS	226L	Weed Science Laboratory	1
CSS	232	Turfgrass Management	4
CSS	262	Turfgrass Management Seminar	2
CSS	267	Performance Turf Design and Construction	2
CSS	269	Turfgrass Strategies: Integration and Synthesis	2
CSS	272	Turfgrass Soil Fertility	2
CSS	282	Turfgrass Physiology	2
ENT	364	Turfgrass Entomology	3
HRT	109	Introduction to Applied Plant Science	2
HRT	213	Landscape Maintenance	2
HRT	213L	Landscape Maintenance Field Laboratory	1
HRT	214	Landscape and Turfgrass Business Operations	2
PLP	266	Turf Pathology	3

Students must enroll in two separate 1 credit sections of CSS 262.

2. Complete a minimum of 2 credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.

Students who do not demonstrate English proficiency through the IAT-administered Accuplacer placement test or college-level transfer credit must complete AT 045 Agricultural Communications (2 credits) or an equivalent course as approved by the program coordinator.

Program offerings in both emphasis areas are integrated with other areas in turfgrass and landscape and nursery. Courses include technical, communication, mathematics, and business content. Placement training opportunities are offered at many leading industrial businesses.

Urban Forest Management

The Urban Forest Management program provides students with the knowledge and technical skills necessary to sustainably manage trees in an urban environment, both in Michigan and beyond. Students connect directly with urban forestry leaders and professionals to gain hands-on experience in areas such as tree identification, tree selection, planting and pruning, climbing and aerial work, tree health care and risk assessment and more. Upon completion of the program, graduates are often in high demand in this growing industry and go on to pursue careers as urban tree planting coordinators; arborists; vegetation mapping coordinators; and urban forest technicians.

Requirements for Urban Forest Management

Students must complete 60 to 61 credits from the following:

1. All of the following courses (36 courses):

AT	293	Professional Internship in Agricultural Technology	3
CSS	143	Introduction to Soil Science	2
ENT	110	Applied Entomology of Economic Plants	3
FOR	111	Field Exploration of Urban and Community Forestry	1
FOR	112	Career Development in Urban and Community Forestry	1
FOR	113	Urban Tree Care Equipment and Worker Safety	2
FOR	114	Introduction to Climbing and Aerial Tree Work	1
FOR	120	Survey of Urban and Community Forestry	2
FOR	125	Methods of Engagement in Urban and Community Forestry	2
FOR	222	Forestry Field Methods	2
FOR	225	Urban Forestry Information Technology	3
FOR	235	Urban Tree Care Practicum	3
FOR	240	Crew Leadership and Management in Arboriculture	2
FOR	245	Capstone Experience in Urban and Community Forestry	2
HRT	211	Landscape Plants I	3
HRT	213	Landscape Maintenance	2
PLP	105	Fundamentals of Applied Plant Pathology	2

2. Complete 24 or 25 credits of additional course work through Muskegon Community College. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Viticulture

The Viticulture program provides students with practical knowledge and training regarding the selection and use of grape production and vineyard management. The program blends a background in plant science with specific viticulture skills, such as soil science, plant diseases, pruning techniques, vineyard management and business management. Students can also choose to take online courses from the Viticulture and Enology Science and Technology Alliance (VESTA). Upon completion of the program, graduates are equipped with the skills needed to pursue a career as a vineyard owner; vineyard manager; vineyard nursery manager; vineyard appraiser; consultant; or viticulturist.

Requirements for Viticulture

Students must complete 48 credits from the following:

1. All of the following courses (23 credits):

			CREDITS
AT	202	Agricultural Regulation, Compliance and Safety	3
AT	293	Professional Internship in Agricultural Technology	3
CSS	126	Introduction to Weed Management	2
CSS	203	World of Soils	2
ENT	110	Applied Entomology of Economic Plants	3
HRT	231	Clerkship in Grape Harvesting and Processing	1
HRT	232	Principles of Viticulture	3
HRT	233	Field Practices of Viticulture	3
HRT	234	Current Issues in Viticulture and Enology	1
PLP	105	Fundamentals of Applied Plant Pathology	1
PLP	105L	Fundamentals of Applied Plant Pathology Lab	1

2. Complete a minimum of 3 elective credits in the College of Agriculture and Natural Resources or VESTA as approved by the program coordinator in the Institute of Agricultural Technology.

3. Complete 22 credits of additional course work through the College of Agriculture and Natural Resources, Northwestern Michigan College or an approved transferring institution. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Admission

The application for admission and admission criteria can be found on the IAT Admissions webpage along with application instructions for freshman, transfer, and international applicants. The IAT application process requires official transcripts from all education institutions attended. Transfer applicants who have completed more than 28 credits of transferrable course work do not need to submit a high school transcript.

The admission process includes a review of the applicant's academic record, work experience, and career interests. Additional items may be requested by the IAT program coordinator such as recommendations from employers, test scores, and an interview.

Financial Aid

The MSU Office of Financial Aid processes aid for IAT students enrolled at the East Lansing main campus. Partnering IAT community colleges process financial aid for students enrolled at any of the approved off campus locations. Students are encouraged to submit the Free Application for Federal Student Aid (FAFSA) to receive the maximum amount of financial aid available. Scholarships for IAT students are sponsored by industry groups and individual businesses and are awarded to students who demonstrate significant academic merit and/or a commitment to an industry.

Veterans Education

IAT certificate programs are approved by the Department of Veterans Affairs as Cooperative Veterans Training Programs. Under some Chapters of Title 38, U.S. Code, veterans may receive educational benefits. Veterans planning to enroll should contact the Veterans Certification Section of the Office of the Registrar to determine their eligibility.

Michigan Works

Students in the Institute of Agricultural Technology are eligible for sponsorship under the guidelines of the Michigan Works Program. Students must arrange sponsorship with the appropriate Michigan Works office.

Transfer Process from IAT to MSU Undergraduate Level

IAT students in their final semester of completing all requirements for their respective certificate program are eligible to apply for an internal transfer to continue their studies at the Michigan State University undergraduate level. The following requirements will determine if an IAT student qualifies for an internal transfer, or change of status, to the MSU undergraduate level.

Complete all certificate program requirements with a minimum 3.0 MSU grade point average (cumulative).

Declare an undergraduate major in the MSU College of Agriculture and Natural Resources.

Be in good standing with Michigan State University and all other post-secondary institutions attended.

Planning to continue at MSU the semester following graduation from the IAT.

Students who meet all the above requirements are eligible to have their status changed from AT to UN upon graduating from the Institute of Agricultural Technology and will be able to enroll in undergraduate courses at that time.

Transfer Process from MSU Undergraduate Level to IAT Current MSU undergraduates can use the internal transfer process to change their enrollment to the IAT. The following requirements will determine if the undergraduate qualifies to have their status changed.

Requirements:
Currently enrolled as an MSU undergraduate student at the time of applying for the status change.

Not enrolled in undergraduate courses for any future semesters.

In good standing with Michigan State University.

Students must submit the Status Change Request Form prior to the start of the semester when they plan to enroll in the IAT.

MSU AgBioResearch

Douglas D. Buhler, Director

The research programs of MSU AgBioResearch help to keep Michigan agriculture competitive, foster stewardship of natural resources, ensure food safety, build stronger, healthier families and communities, and spur economic development throughout the state. The mission of AgBioResearch - to engage in innovative, leading edge research that ensures the wise use of agricultural, natural and community resources and enhances the quality of life in Michigan, the nation and the world - is an integral part of Michigan State University's responsibilities as a land-grant university.

AgBioResearch is composed of a network of on-campus laboratories and research centers across the state. More than 330 faculty members from 30 academic departments, research institutes and laboratories across MSU receive support from AgBioResearch. In addition to the College of Agriculture and Natural Resources, AgBioResearch is affiliated with the College of Arts and Letters, College of Communication Arts and Sciences, College of Engineering, College of Natural Science, College of Osteopathic Medicine, College of Social Science, and the College of Veterinary Medicine. AgBioResearch helps Michigan agriculture compete nationally and globally by developing ways to increase production efficiency, improve product quality and meet market needs. Other research focuses on food safety and security, natural resource management and the emerging bioeconomy. Research also concentrates on

economic development, recreation and tourism, climate change and water quality.

AgBioResearch activities are conducted in laboratories, greenhouses and several south campus experimental lands in East Lansing. Research also takes place at the 14 off-campus field research centers ranging from a forest biomass innovation center in the Upper Peninsula to fruit and vegetable research centers in the southernmost counties of the state.

AgBioResearch, following in the land-grant tradition, is about more than agriculture. It is an idea for higher education that com-bines practical information with innovative scientific studies to generate knowledge to meet rapidly changing needs in the state and nation.

Organized under the Hatch Act of 1887, AgBioResearch has been part of Michigan State University for most of the university's 150-year history. Funding comes from the state and federal governments, commodity groups, industries, foundations and individuals.

MICHIGAN STATE UNIVERSITY EXTENSION

Quentin R. Tyler, Director

Michigan State University (MSU) Extension is the main outreach arm of MSU. Thanks to more than 600 faculty and staff members located throughout Michigan, Extension provides education and resources to help people improve their families, communities and businesses. Whether it is helping grow Michigan's agricultural economy, capturing opportunities that use our natural resources sustainably, controlling healthcare costs by giving individuals the information they need to manage chronic illness, or preparing tomorrow's leaders, MSU Extension is creating opportunities and building communities that make Michigan strong, prosperous and a great place to live.

Because of its vast network of professionals with relationships through the state, MSU Extension is a nimble organization that can quickly respond to emergent issues. For example, when the Flint water crisis hit, MSU Extension was quick to respond with nutrition education for affected residents. When farm prices dropped dramatically, the organization was able to immediately provide stress management workshops to help the state's farmers and their families. The MSU Extension behavioral health team provides educational materials and resources to families struggling with opioid addiction.

Established in 1914, MSU Extension thrives on a three-way partnership between the U.S. Department of Agriculture and state and local governments. Campus-based faculty members in four MSU colleges share expertise derived from research and other scholarly activities to support local Extension programs.

MSU Extension offers summer internship opportunities for young people eager to make a positive difference in Michigan communities. Interns have an opportunity to learn about Extension programming in all four statewide program areas: agriculture and agribusiness, health and nutrition, children and youth, and community, food and environment.

Agriculture and Agribusiness

Agriculture continues to be an important economic driver in Michigan. MSU Extension works with all segments of Michigan agriculture to support the production of safe, high-quality, nutritious food and biobased fuels and materials. MSU Extension develops and delivers science-based research and need-based programming to advance the profitability and sustainability of Michigan farms, to help producers improve water and land stewardship, and to increase consumer understanding of modern agriculture. Programs are also available for beginning farmers and those considering new ventures in specialty crops or alternative commodities. In addition, MSU Extension provides counseling for food and agricultural entrepreneurs, including reviewing new business ventures that explore the development of value-added products. All of these efforts help to position Michigan as a leader in providing affordable, quality, safe food for local, national and international markets.

Health and Nutrition

Michigan State University Extension's strength is its community-based approach to meeting local needs and its unwavering efforts to serve the needs of children, families and communities, regardless of whether they are in urban, suburban or rural settings. In all of its programming, MSU Extension promotes healthy lifestyles and equips Michigan residents to take control of their health through research-based education and action-oriented tools. Our goal is to help people lead healthy lives and contribute to their communities.

Children and Youth

The goal of MSU Extension's children and youth programs is to ensure that every Michigan child has the necessary knowledge, tools and skills to lead a healthy and productive life. By providing children with a continuum of learning opportunities, resources and support from birth through age 19, MSU Extension helps to prepare Michigan youth for the future.

MSU Extension's early childhood education programs serve families of children from birth to age 8 by providing parents and caregivers with educational resources related to child development, emerging literacy and school readiness. As youth become older, ages 5-19, MSU Extension supports them through Michigan 4-H. This program helps young people learn critical life skills while exploring their interests and passions. Through hands-on learning opportunities with positive adult role models, youth experience the benefits of working together while growing their confidence, civic engagement and leadership skills, and sense of responsibility. All programs encourage the development of employability skills and career exploration and are available in hundreds of project areas, including science and technology, arts and global education, healthy living,

leadership and service, environmental education, animal science and entrepreneurship.

Community, Food and Environment

MSU Extension faculty and staff members help residents build stronger communities by enhancing community engagement, strengthening government leadership and financial structures, advancing entrepreneurship, fostering natural resources stewardship, developing local food systems and enhancing the quality of place. Outreach programs in home ownership and financial literacy education also strengthen Michigan communities and families.

MSU PRODUCT CENTER

Mollie Woods, Director

The MSU Product Center was established in 2003, by the Michigan Agricultural Experiment Station (now AgBioResearch) and Michigan State University Extension, to improve economic opportunities in the Michigan agriculture, food and bio-products sectors. The Product Center assists new entrepreneurs and existing businesses to develop and commercialize high value, consumer-responsive products and services. The Center serves as a single doorway for these businesses to MSU's vast and varied technical expertise, research, outreach, and educational services related to food and agriculture. The Center has four interrelated programs: Venture Development, Accelerated Growth Services, the Food Processing and Innovation Center (FPIC) and Strategic Research.

Venture Development utilize campus-based staff and the statewide MSUE Innovation Counselors Network to counsel business ventures from earliest idea to venture launch. In addition to business development, technical expertise in product development, food processing, labeling, and regulatory compliance is provided.

Accelerated Growth Services provides counseling and strategic planning services to well-established agriculture and food businesses that have opportunities for growth. Also serving growth-stage businesses is the FPIC, which is a fully-licensed food processing plant, where later-stage food companies can test new product lines and sell this product into the marketplace, reducing their risk.

At all levels of venture size and scope, counselors nurture new market and product development opportunities by tapping into Michigan State University's technical expertise. Project specialists also collaborate with external consultants, industry groups and governmental agencies.

Strategic Research develops the information needed to support evaluation of concepts, products and businesses. It also produces long-range studies for Michigan's agricultural, food and bio-products sectors. Most important among these is periodic estimates of the economic value of Michigan's food and agricultural system, and the Michigan Food and Agricultural Index. This information is crucial to public and private decision makers.

INSTITUTE of WATER RESEARCH

Dana Infante, Acting Director

The Michigan State University Institute of Water Research promotes and coordinates water research, education, outreach, and advisory services for the inland waters and Great Lakes of Michigan. Serving as a bridging organization, the Institute works across disciplinary boundaries and develops partnerships with campus departments, local and state agencies, and other Universities and organizations in the broad water arena. Established in 1961, the Institute is a focal point to which University and off-campus communities can turn for advice and assistance in support of water research issues. It is one of 54 state institutes designated by Congress to administer research funds authorized under the Water Research Resources Act of 1984. With this base and through private, state, and federal funds, the Institute supports integrated research projects for faculty and graduate students on campus and in other universities. The Institute provides leadership in building partnerships and implementing programs at the state, regional, and international level, and in solving real-world water-related problems. It uses advanced data management, decision support systems, integrated social networking components, and cutting-edge technology to address land and water resources issues such as nonpoint source pollution, nutrient reduction and ecological processes. The Institute also coordinates online education and training programs for surface and ground water protection and watershed management. Through its outreach programming and dissemination of information on water research, the Institute provides citizens throughout the state and region with science-based information and knowledge that enables them to make better informed decisions regarding water issues.