College of AGRICULTURE and NATURAL RESOURCES

Ronald Hendrick,
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, and natural resources. 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, 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 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, 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, freshmen 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 Specialization in Environmental Studies. For additional information, refer to the *Specialization in Environmental 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
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; 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; human nutrition—environmental toxicology; 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 degree programs in the College of Agriculture and Natural Resources may elect the master's Specialization in Agribusiness. For additional information, refer to the *Specialization in Agribusiness Management* statement in the *Department of Agricultural, Food, and Resource Economics* section of this catalog.

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 degree programs in the departments of Agricultural, Food, and Resource Economics, Biosystems and Agricultural Engineering, Animal Science, Entomology, Food Science and Human Nutrition, Horticulture, and Packaging may elect a *Specialization in Food Safety*. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

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 collat-

eral 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):			
	CSUS	846	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
	MMG	425	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:

			CREDITS
1. Complete all of the following courses (10 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:

			CREDITS
1. Both of the following courses:			
ANP	859	Gender, Justice, and Environmental Change: Methods and Application	3
FW	858	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 NO–PREFERENCE UNDERGRADUATE PROGRAM

An Agriculture and Natural Resources no–preference 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 no–preference 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

Titus O. Awokuse, 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: Agribusiness Management 437, Environmental Economics and Policy 405, or Food Industry Management 439. Those courses are referenced in item 3. below.

   The completion of the Agribusiness Management mathematics requirement may also satisfy the College of Agriculture and Natural Resources and 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.

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

   Agribusiness Management 437 or Food Industry Management 439 and Environmental Economics and Policy 405 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. c. Agribusiness Management 130 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. e.
3. The following requirements for the major:

				CREDITS
a.	All of the following courses:			44
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	203	Data Analysis for the Agri-Food System	3
	ABM	210	Professional Seminar in Agribusiness Management	1
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ABM	225	Commodity Marketing I	3
	ABM	410	Advanced Professional Seminar in Agribusiness Management	1
	ABM	422	Vertical Coordination in the Agri-Food System	3
	ABM	435	Financial Management in the Agri-Food System	3
	ACC	230	Survey of Accounting Concepts	3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
	EEP	260	World Food, Population and Poverty	3
	FIM	220	Food Product Marketing	3
	MKT	327	Introduction to Marketing	3
	MTH	124	Survey of Calculus I	3
	SCM	303	Introduction to Supply Chain Management	3
b.	Four of the following courses:			12
	ABM	130	Farm Management I	3
	ABM	337	Labor and Personnel Management in the Agri-Food System	3
	ABM	400	Public Policy Issues in the Agri-Food System	3
	ABM	425	Commodity Marketing II	3
	ABM	427	Global Agri-Food Industries and Markets	3
	ABM	430	Farm Management II	3
	ABM	437	Agribusiness Strategic Management (W)	3
	ABM	490	Independent Study	3
	ABM	493	Professional Internship in Agribusiness Management	3
	EEP	405	Corporate Environmental Management (W)	3
	FIM	335	Food Marketing Management	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
	FIM	460	Retail Information Systems	3
	GBL	323	Introduction to Business Law	3
	MGT	325	Management Skills and Process	3
	Study Abroad as approved by academic advisor			
c.	One of the following courses:			3
	ABM	437	Agribusiness Strategic Management (W)	3
	EEP	405	Corporate Environmental Management (W)	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
d.	One of the following courses:			3 or 4
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	315	Introduction to Probability and Statistics for Business	3
e.	One of the following courses:			3
	ABM	130	Farm Management I	3
	FI	320	Introduction to Finance	3
f.	One of the following courses:			3
	ABM	303	Economics of Decision Making in the Agri-Food System	3
	EC	301	Intermediate Microeconomics	3
g.	Complete 6 credits from the same science discipline as approved by the academic advisor.			

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 Agribusiness Management 437 or Food Industry Management 439. Those courses are referenced in item 3. below.
   The completion of the Food Industry Management mathematics requirement may also satisfy the College of Agriculture and Natural Resources and 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.
   Students must achieve a grade of at least 2.0 or higher in each ABM and FIM and EEP course referenced in items 3. a. and in courses taken to fulfill requirements 3. b., 3. c., and 3. d.
   Agribusiness Management 435 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. c.
   Environmental Economics and Policy 405 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. c.
   Agribusiness Management 130 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. d.
3. The following requirements for the major:

				CREDITS
a.	All of the following courses:			41
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	203	Data Analysis for the Agri-Food System	3
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ACC	230	Survey of Accounting Concepts	3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
	EEP	260	World Food, Population and Poverty	3
	FIM	210	Professional Seminar in Food Industry Management	1
	FIM	220	Food Product Marketing	3
	FIM	335	Food Marketing Management	3
	FIM	410	Advanced Professional Seminar in Food Industry Management	1
	FIM	460	Retail Information Systems	4
	MKT	327	Introduction to Marketing	3
	MTH	124	Survey of Calculus I	3
	SCM	303	Introduction to Supply Chain Management	3
b.	One of the following courses (3 credits):			
	ABM	437	Agribusiness Strategic Management (W)	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
c.	Four of the following courses:			12
	ABM	130	Farm Management I	3
	ABM	225	Commodity Marketing I	3
	ABM	400	Public Policy Issues in the Agri-Food System	3
	ABM	422	Vertical Coordination in the Agri-Food System	3
	ABM	425	Commodity Marketing II	3
	ABM	427	Global Agri-Food Industries and Markets	3
	ABM	435	Financial Management in the Agri-Food System	3
	EEP	405	Corporate Environmental Management (W)	3
	FIM	224	Information and Market Intelligence in the Agri-Food Industry	3
	FIM	415	Human Resource Management: Changes and Challenges	3
	FIM	490	Independent Study in Food Industry Management	3
		or		
	FIM	493	Professional Internship in Food Industry Management	3
	GBL	323	Introduction to Business Law	3
	MGT	325	Management Skills and Processes	3
	MKT	351	Retail Management	3
	A study abroad experience may also fulfill part of this requirement through enrollment in FIM 490 or FIM 493 with approval by the academic advisor.			
d.	One of the following courses:			3
	ABM	435	Financial Management in the Agri-Food System	3
	EEP	405	Corporate Environmental Management	3
e.	One of the following courses:			3
	ABM	130	Farm Management I	3
	FI	320	Introduction to Finance	3
f.	One of the following courses:			3 or 4
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	315	Introduction to Probability and Statistics for Business	3
g.	One of the following courses:			3
	ABM	303	Economics of Decision Making in the Agri-Food System	3
	EC	301	Intermediate Microeconomics	3
h.	Complete 6 credits from the same science discipline as approved by the academic advisor.			

ENVIRONMENTAL ECONOMICS AND MANAGEMENT

Environmental Economics and Management prepares students for careers that require successful reconciliation of environmental sustainability and economic performance goals for businesses. The major develops skills in core business disciplines, environmental economics, and environmental policy analyses, and applies these skills and knowledge to help manage or create environmentally-sustainable and socially-responsive business organizations that also deliver shareholder value. The major prepares students for employment opportunities with industry, environmental consulting firms, state and federal government agencies, and environmental interest groups. The major also offers students the opportunity to prepare for graduate study in business or environmental economics and policy studies 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 Environmental Economics and Policy 405. That course is referenced in item 3. a. below.
   The completion of the Environmental Economics and Management mathematics requirement may also satisfy the College of Agriculture and Natural Resources and 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.
   Students must achieve a grade of at least 2.0 or higher in each ABM and FIM and EEP course referenced in items 3. a. and in courses taken to fulfill requirements 3. b., 3. c., and 3. d.
   Agribusiness Management 435 and 437 and Food Industry Management 439 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. c.
   Agribusiness Management 130 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. d.
3. The following requirements for the major:

				CREDITS
a.	All of the following courses:			44
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	210	Professional Seminar in Agribusiness Management	1
	ABM	410	Advanced Professional Seminar in Agribusiness Management	1
	ACC	230	Survey of Accounting Concepts	3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
	EEP	255	Ecological Economics	3
	EEP	260	World Food, Population and Poverty	3
	EEP	320	Environmental Economics	3
	EEP	405	Corporate Environmental Management (W)	3
	EEP	460	Natural Resource Economics	3
	FIM	203	Data Analysis for the Agri-Food System	3
	FIM	220	Food Product Marketing	3
	MKT	327	Introduction to Marketing	3

	MTH	124	Survey of Calculus I	3
	SCM	303	Introduction to Supply Chain Management	3
b.	Four of the following courses:			12
	ABM	130	Farm Management I	3
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ABM	225	Commodity Marketing I	3
	ABM	337	Labor and Personnel Management in the Agri-Food System	3
	ABM	400	Public Policy Issues in the Agri-Food System	3
	ABM	422	Vertical Coordination in the Agri-Food System	3
	ABM	425	Commodity Marketing II	3
	ABM	427	Global Agri-Food Industries and Markets	3
	ABM	430	Farm Management II	3
	ABM	435	Financial Management in the Agri-Food System	3
	ABM	437	Agribusiness Strategic Management (W)	3
	CSUS	354	Water Resources Management	3
	CSUS	429	Program Evaluation for Community Sustainability	3
	CSUS	464	Environmental and Natural Resource Policy in Michigan	3
	CSUS	465	Environmental and Natural Resource Law	3
	EEP	404	Public Sector Budgeting and Program Evaluation (W)	3
	EEP	490	Independent and Supervised Study	3
	EEP	493	Professional Internship in Environmental Economics and Policy	3
	FIM	224	Information and Market Intelligence in the Agri-Food Industry	3
	FIM	335	Food Marketing Management	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
	FOR	466	Natural Resource Policy	3
	FW	419	Applications of Geographic Information Systems to Natural Resource Management	4
	MGT	325	Management Skills and Processes	3
	Study Abroad as approved by academic advisor			
c.	One of the following courses:			3
	ABM	435	Financial Management in the Agri-Food System	3
	ABM	437	Agribusiness Strategic Management (W)	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
d.	One of the following courses:			3
	ABM	130	Farm Management I	3
	FI	320	Introduction to Finance	3
e.	One of the following courses:			3 or 4
	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
	ABM	303	Economics of Decision Making in the Agri-Food System	3
	EC	301	Intermediate Microeconomics	3
g.	Complete 6 credits from the same science discipline as approved by the academic advisor.			

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 specialization 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 12 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:

				CREDITS
1.	One of the following courses:			3
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	130	Farm Management I	3
2.	One of the following courses:			3
	ABM	225	Commodity Marketing I	3
	ABM	430	Farm Management II	3
	ABM	435	Financial Management in the Agri-Food System	3
3.	Two of the following courses including at least one course at the 300 or 400 level. Courses not used to satisfy requirements 1. and 2. may be used to substitute for courses listed in requirement 3.			6
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ABM	337	Labor and Personnel Management in the Agri-Food System	3
	ABM	400	Public Policy Issues in the Agri-Food System	3
	ABM	422	Vertical Coordination in the Agri-Food System	3
	ABM	425	Commodity Marketing II	3
	ABM	427	Global Agri-Food Industries and Markets	3
	ABM	437	Agribusiness Strategic Management (W)	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
4.	One of the following courses:			3
	ACC	201	Principles of Financial Accounting	3
	ACC	230	Survey of Accounting Concepts	3
5.	One of the following courses:			3
	GBL	323	Introduction to Business Law	3
	MGT	325	Management Skills and Processes	3
	MKT	327	Introduction to Marketing	3

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. The minor is administered by the Department of Agricultural, Food, and Resource Economics.

At least 12 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 18 credits:

				CREDITS
1.	One of the following courses:			3 or 4
	EC	201	Introduction to Microeconomics	3
	EC	251H	Microeconomics and Public Policy	4
	EC	301	Intermediate Microeconomics	3
2.	All of the following courses:			12
	EEP	255	Ecological Economics	3
	EEP	320	Environmental Economics	3
	EEP	405	Corporate Environmental Management (W)	3
	EEP	460	Natural Resource Economics	3
3.	One of the following courses:			3 or 4
	CSUS	354	Water Resources Management	3
	CSUS	425	Environmental Impact Assessment	3
	CSUS	429	Program Planning and Evaluation	3
	CSUS	464	Environmental and Natural Resource Policy in Michigan	3
	CSUS	465	Environmental and Natural Resource Law	3
	EC	450	Economics of Environmental Policy (W)	3
	FOR	466	Natural Resource Policy	3
	FW	364	Ecological Problem Solving	3
	GEO	324	Remote Sensing of the Environment	4
	GEO	402	Agricultural Climatology	3
	PKG	370	Packaging and the Environment	3

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 12 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:

				CREDITS
1.	Both of the following courses:			6
	ABM	100	Decision-making in the Agri-Food System	3
	FIM	220	Food Product Marketing	3
2.	Two of the following courses:			6
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ABM	400	Public Policy Issues in the Agri-Food System	3
	ABM	422	Vertical Coordination in the Agri-Food System	3
	ABM	427	Global Agri-Food Industries and Markets	3
	ABM	435	Financial Management in the Agri-Food System	3
	ABM	437	Agribusiness Strategic Management (W)	3
	EEP	405	Corporate Environmental Management	3
	FIM	335	Food Marketing Management	3
	FIM	415	Human Resource Management: Changes and Challenges	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
	MKT	351	Retail Management	3
3.	One of the following courses:			3
	ACC	201	Principles of Financial Accounting	3
	ACC	230	Survey of Accounting Concepts	3
4.	One of the following courses:			3
	ABM	437	Agribusiness Strategic Management (W)	3
	FIM	335	Food Marketing Management	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
	GBL	323	Introduction to Business Law	3
	MGT	325	Management Skills and Processes	3
	MKT	327	Introduction to Marketing.	3
	SCM	303	Introduction to Supply Chain Management	3

Courses used to fulfill this requirement may not be 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.

Students who are enrolled in Master of Science degree programs in the Department of Agricultural, Food, and Resource Economics may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

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

AGRICULTURAL, FOOD and RESOURCE ECONOMICS

Admission

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.

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.

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

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 semester 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. A grade-point average of at least 3.0 for all courses counting toward the master's degree , and in each course used to satisfy the mathematics, statistics, and quantitative methods requirements.
2. A minimum of 12 credits in courses in agricultural, food and resource economics, with at least 9 credits at the 800-900 level.
3. A minimum of 3 credits in courses in microeconomic theory, selected from AFRE 805, EC 812A or equivalent.
4. A minimum of 9 credits in courses in quantitative analysis, including 3 credits of mathematics for economists (equivalent to AFRE 801 or EC 811A), 3 credits of statistics (AFRE 802, EC 820A or equivalent) and one elective 3 credit quantitative methods course.

Additional Requirements for Plan A:

1. Six credits of master's thesis research.

Additional Requirements for Plan B:

1. A research paper or papers representing not fewer than 3 credits.
2. Six credits in courses in a minor field, either within or outside the department.

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 Agricultural, Food and Resource Economics

The student must:

				CREDITS
1.	Complete all of the following courses (20 credits):			
	AFRE	900A	Applied Microeconomics I	3
	AFRE	900B	Applied Microeconomics II	3
	EC	811A	Mathematical Applications in Economics	2

EC	812A	Microeconomics I	3
EC	812B	Microeconomics II	3
EC	820A	Econometrics IA	3
EC	820B	Econometrics IB	3

2. Complete 9 credits in one of four major fields in Agricultural, Food and Resource Economics: development economics, environmental and resource economics, food and agribusiness management, or food and agricultural markets.
3. Complete 6 credits in a second major field in Agricultural, Food and Resource Economics.
4. Complete 6 credits of electives in courses not used to fulfill requirements 1., 2., and 3.
5. Pass written comprehensive examinations in microeconomic theory and econometrics (requirement 1.) no later than the end of the second year and in the student's chosen major field (requirement 2.) by the end of the third year.
6. Complete a minimum of 24 credits of doctoral dissertation research in AFRE 999.
7. Present and obtain formal approval for the proposed dissertation research by the end of the fourth academic year.
8. Present the results of the research at the outset of the final oral examination, and prepare a research paper suitable for submission to a professional journal.
9. A grade point average of 3.0 in the student's approved course program is required before the student can be certified for graduation. Collateral courses are not included in this calculation.

DEPARTMENT of ANIMAL SCIENCE

Janice C. Swanson, Chairperson

UNDERGRADUATE PROGRAM

The undergraduate program in animal science, which leads to the Bachelor of Science degree, is designed to prepare students for a variety of careers by establishing a strong basic science foundation combined with practical experience with agricultural animals at the multiple farm facilities located near campus. Graduates may be employed in farm ownership, management, marketing, agribusiness, finance, manufacturing, public relations, extension, or consulting. Graduates often attend veterinary or graduate school.

Scientific principles of biology and animal science are important components of the program and are combined with opportunities to apply fundamental principles learned in class to farm management. The animal science major also provides students with flexibility. Academic advisors guide students in the development of a planned program of study that is consistent with their interests and goals.

All students in animal science must complete a set of required core courses including breeding and genetics, nutrition, physiology, and management. These principles are taught using horses, dairy cattle, beef cattle, swine, poultry, sheep and companion animals.

Students must choose from one of the following concentrations: animal industry, companion and exotic animal biology, animal biology/preveterinary, or production animal scholars.

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 the College of Veterinary Medicine.

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 the College of Veterinary Medicine are included in the requirements for this concentration.

The production animal scholars concentration is a cooperative effort between the Department of Animal Science and the College of Veterinary Medicine. The concentration is for students committed to a career in food animal management and medicine and provides an admissions pathway to Production Medicine Scholars in the College of Veterinary Medicine. Students must (1) declare the concentration when they reach junior standing; (2) submit a formal application for the production animal scholars concentration; (3) demonstrate a commitment to livestock agriculture, excluding horses, through youth activities, family experiences, employment, internships, extracurricular activities, and other participation in the livestock industry.

After completion of the production animal scholars concentration, students will earn a Bachelor of Science degree in Animal Science. Students may then enter veterinary college or pursue a career in farm-based, agricultural veterinary practice. Students completing this concentration must complete the Bachelor of Science degree in Animal Science prior to matriculation into the College of Veterinary Medicine. Students interested in pursuing the admissions pathway to Production Medicine Scholars in the College of Veterinary Medicine should see the *College of Veterinary Medicine* section of this catalog for further information.

Students who are enrolled in the Bachelor of Science degree program with a major in animal science may elect a Specialization in Agricultural and Natural Resources Biotechnology. For additional information, refer to the *Specialization in Agricultural and Natural Resources 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 all of the following courses: Animal Science 313, 314, 315. 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 111 and 111L, Chemistry 141, and Chemistry 143 or 251. The completion of Biological Science 111L satisfies the laboratory requirement. Biological Science 111 and 111L, 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:			29
	ANS	101	Professional Development in Animal Science I	1
	ANS	110	Introductory Animal Agriculture	4
	ANS	301	Professional Development in Animal Science II	2
	ANS	313	Principles of Animal Feeding and Nutrition	4
	ANS	314	Genetic Improvement of Domestic Animals	4
	ANS	315	Anatomy and Physiology of Farm Animals	4
	ANS	401	Issues in Animal Agriculture	1
	BS	111	Cells and Molecules	3
	BS	111L	Cell and Molecular Biology Laboratory	2
	CEM	141	General Chemistry	4
b.	One of the following courses:			3 or 4
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	421	Statistics I	3
	STT	464	Statistics for Biologists	3
c.	One of the following courses:			3 or 4
	CEM	143	Survey of Organic Chemistry	4
	CEM	251	Organic Chemistry I	3
d.	One of the following species management courses:			3
	ANS	222	Introductory Beef Cattle Management	3
	ANS	232	Introductory Dairy Cattle Management	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	Introductory Companion Animal Management	3
e.	One of the following concentrations:			23 to 55

Animal Industry (23 to 34 credits):
1. The following course (4 credits):
   ANS 210 Animal Products 4
2. One of the following courses (2 or 3 credits):
   CSE 101 Computing Concepts and Competencies 3
   CSS 110 Computer Applications in Agronomy 2
3. One of the following courses (3 credits):
   ABM 100 Decision-making in the Agri-Food System . . . 3
   ABM 130 Farm Management I 3
4. One of the following courses (3 credits):
   ANS 222 Introductory Beef Cattle Management. 3
   ANS 232 Introductory Dairy Cattle Management 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
   The course used to fulfill this requirement may not be used to fulfill requirement 3. d. above.
5. One of the following courses (3 credits):
   ANS 422 Advanced Beef Cattle Management 3
   ANS 432 Advanced Dairy Cattle Management. 3
   ANS 442 Advanced Horse Management 3
   ANS 472 Advanced Swine Management 3
   ANS 482 Advanced Companion Animal Management. . 3
6. Three of the following courses (6 to 12 credits):
   ANS 305 Applied Animal Behavior 3
   ANS 309 Health and Hygiene of Livestock. 3
   ANS 404 Advanced Animal Genetics 2
   ANS 405 Endocrinology of Reproduction 4
   ANS 407 Food and Animal Toxicology 3
   ANS 413 Monogastric Animal Nutrition 3
   ANS 414 Advanced Animal Breeding 2
   ANS 415 Growth and Musculoskeletal Biology 3
   ANS 416 Meat Science and Muscle Biology 2
   ANS 418 Comprehensive Nutrient Management Planning 3
   ANS 435 Mammary Physiology 4
   ANS 445 Equine Exercise Physiology 4
   ANS 455 Avian Physiology 4
   ANS 483 Ruminant Nutrition 3
7. One of the following courses (2 to 6 credits):
   ANS 493 Professional Internship in Animal Science . . . 3
   ANS 300A Advanced Livestock Judging. 2
   ANS 300C Advanced Dairy Cattle Judging 2
   ANS 300D Advanced Horse Judging 2
   Six credits in an approved Study Abroad program can be used to fulfill this requirement.

Animal Biology and Preveterinary (39 to 50 credits):
1. All of the following courses (22 credits):
   ANS 210 Animal Products 4
   ANS 425 Principles of Animal Biotechnology 3
   BMB 401 Basic Biochemistry 4
   BS 110 Organisms and Populations 4
   CEM 161 Chemistry Laboratory I 1
   CEM 252 Organic Chemistry II 3
   CEM 255 Organic Chemistry Laboratory 2
2. Three of the following courses (7 to 11 credits):
   ANS 404 Advanced Animal Genetics 2
   ANS 405 Endocrinology of Reproduction 4
   ANS 413 Monogastric Animal Nutrition 3
   ANS 415 Growth and Musculoskeletal Biology 3
   ANS 416 Meat Science and Muscle Biology 2
   ANS 435 Mammary Physiology 4
   ANS 483 Ruminant Nutrition 3
3. A minimum of 8 credits from the following courses (8 to 12 credits):
   ANS 305 Applied Animal Behavior 3
   ANS 309 Health and Hygiene of Livestock. 3
   ANS 407 Food and Animal Toxicology 3
   ANS 414 Advanced Animal Breeding 2
   ANS 418 Comprehensive Nutrient Management Planning 3
   ANS 445 Equine Exercise Physiology 4
   ANS 455 Avian Physiology 4
   MMG 301 Introductory Microbiology 3
   MMG 302 Introductory Laboratory for General and Allied Health Microbiology 1
   MMG 409 Eucaryotic Cell Biology 3
   PHM 450 Introduction to Chemical Toxicity 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
   ZOL 313 Animal Behavior 3
   ZOL 341 Fundamental Genetics 4
4. One of the following courses (3 to 6 credits):
   ANS 492 Undergraduate Research in Animal Science . 3
   ANS 493 Professional Internship in Animal Science . . . 3
   Six credits in an approved Study Abroad program can be used to fulfill this requirement.

Companion and Exotic Animal Biology (43 to 52 credits)
1. All of the following courses (19 credits):
   ANS 282 Companion Animal Biology and Management 3
   ANS 482 Advanced Companion Animal Management . . 3
   BS 110 Organisms and Populations 4
   CEM 252 Organic Chemistry II 3
   CEM 255 Organic Chemistry Laboratory 2
   ZOL 328 Comparative Anatomy and Biology of Vertebrates (W). 4
2. One of the following courses (4 credits):
   BMB 200 Introduction to Biochemistry 4
   BMB 401 Basic Biochemistry 4
3. Two of the following courses (6 to 8 credits):
   ANS 305 Applied Animal Behavior 3
   ANS 405 Endocrinology of Reproduction 4
   ANS 413 Monogastric Animal Nutrition 3
   ANS 435 Mammary Physiology 4
   ANS 483 Ruminant Nutrition 3
4. Four of the following courses (11 to 15 credits):
   ANS 404 Advanced Genetics 2
   ANS 407 Food and Animal Toxicology 3
   ANS 415 Growth and Musculoskeletal Biology 3
   ANS 418 Comprehensive Nutrient Management Planning 3
   ANS 425 Principles of Animal Biotechnology 3
   ANS 445 Equine Exercise Physiology 4
   ANS 455 Avian Physiology 4
   ZOL 313 Animal Behavior 3
   ZOL 341 Fundamental Genetics 4
   ZOL 355 Ecology 3
   ZOL 369 Introduction to Zoo and Aquarium Science . . . 3
5. One of the following courses (3 to 6 credits):
   ANS 492 Undergraduate Research in Animal Science . 3
   ANS 493 Professional Internship in Animal Science . . . 3
   Six credits in an approved Study Abroad program can be used to fulfill this requirement.

Production Animal Scholars (52 to 55 credits):
1. All of the following courses (33 credits):
   ANS 210 Animal Products 4
   BMB 401 Basic Biochemistry 4
   BS 110 Organisms and Populations 4
   CEM 161 Chemistry Laboratory I 1
   CEM 252 Organic Chemistry II 3
   CEM 255 Organic Chemistry Laboratory 2
   MMG 301 Introductory Microbiology 3
   MMG 302 Introductory Laboratory for General and Allied Health Microbiology. 1
   MMG 409 Eucaryotic Cell Biology 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
2. One of the following courses (3 credits):
   ANS 222 Introductory Beef Cattle Management. 3
   ANS 232 Introductory Dairy Cattle Management 3
   ANS 252 Introduction to Management of Avian Species 3
   ANS 262 Introductory Sheep Management 3
   ANS 272 Introductory Swine Management. 3
   The course used to fulfill this requirement may not be used to fulfill requirement 3. d. above.
3. Two of the following courses (6 credits):
   ABM 435 Financial Management in the Agri-Food System 3
   ABM 437 Agribusiness Strategic Management (W) 3
   ANS 413 Monogastric Animal Nutrition 3
   ANS 483 Ruminant Nutrition 3
4. One of the following courses (3 to 4 credits):
   ANS 305 Applied Animal Behavior 3
   ANS 405 Endocrinology of Reproduction 4
   ANS 415 Growth and Musculoskeletal Biology 3
   ANS 425 Principles of Animal Biotechnology 3
   ANS 435 Mammary Physiology 4
5. One of the following courses (3 credits):
   ANS 422 Advanced Beef Cattle Management 3
   ANS 432 Advanced Dairy Cattle Management. 3
   ANS 472 Advanced Swine Management 3
6. One of the following courses (2 to 4 credits):
   ANS 404 Advanced Animal Genetics 2
   ANS 407 Food and Animal Toxicology 3
   ANS 414 Advanced Animal Breeding 2
   ANS 416 Meat Science and Muscle Biology 2
   ANS 418 Comprehensive Nutrient Management Planning 3
   ANS 455 Avian Physiology 4
   ZOL 313 Animal Behavior 3
   ZOL 341 Fundamental Genetics 4
7. The following course (2 credits):
   ANS 390 Animal Science Practicum 2

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 and a Doctor of Philosophy degree program in animal science-environmental toxicology.

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.

Students who are enrolled in Master of Science degree programs in the Department of Animal Science may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* 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.

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 total of 30 credits is required for the degree under either Plan A or Plan B. 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 thesis research for students under Plan A.

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.

ANIMAL SCIENCE—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in animal science—environmental toxicology, refer to the statement on *Doctoral Program in Environmental and Integrative Toxicological Sciences* in the *Graduate Education* section of this catalog.

DEPARTMENT of BIOSYSTEMS and AGRICULTURAL ENGINEERING

Darrell W. Donahue, 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

Students must complete a minimum of 15 credits from the following:

				CREDITS
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
	CSUS	354	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.

Students who are enrolled in Master of Science degree programs in the Department of Biosystems and Agricultural Engineering may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

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

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 the written thesis administered by the department and conducted by three regular university faculty members, at least two of which must be Biosystems Engineering faculty.
3. Provide to the major professor and to the department a hard–bound copy of the thesis made from the original unbound manuscript submitted to the Office of The Graduate School. Arrangement for delivery of the copies shall be made when the original manuscript is submitted to the Office of The Graduate School.

Additional Requirements for Plan B:
The student must:
Pass the final examination administered by the department over the course work in the student's approved program of study. The examination may include both a written and an oral component. It is the student's responsibility to obtain detailed information about this examination from the department.

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 24 credits in Biosystems Engineering 999.
2. Complete a minimum of 38 additional credits (excluding Biosystems Engineering 899) beyond the bachelor's degree, in courses at the 400–, 800–, and 900–level including:
   a. 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
   b. Additional course work approved by the student's guidance committee, based on the student's prior academic background in relation to the selected area of study and research.
3. Pass the doctoral comprehensive examination within five years of the date of first enrollment and at least six months prior to the final oral examination in defense of the dissertation. The examination may be retaken once. It is the student's responsibility to obtain detailed information about this examination from the department.

4. Pass the examination in defense of the dissertation. The examination may be retaken once.
5. Provide to the major professor and to the department a hard–bound copy of the dissertation made from the original unbound manuscript submitted to the Office of The Graduate School. Arrangements for delivery of the copies shall be made when the original manuscript is submitted to the Office of The Graduate School.

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 Potentia**l. 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

Michael W. Hamm, Acting Chairperson

The Department of Community Sustainability is an interdisciplinary department that offers programs leading to the Bachelor of Science, 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 325 or 433. Those courses are 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:

   CREDITS

   a. All of the following courses (53 credits):

ANS	110	Introductory Animal Agriculture	4
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
CSUS 200 Introduction to Sustainability . . . 3
CSUS 300 Theoretical Foundations of Sustainability . . . 3
CSUS 301 Community Engagement for Sustainability . . . 3
CSUS 322 Leadership for Community Sustainability . . . 3
CSUS 343 Community Food and Agriculture Systems . . . 3
FOR 202 Introduction to Forestry . . . 3
HRT 203 Principles of Horticulture . . . 3
IBIO 355 Ecology . . . 3
IBIO 355L Ecology Laboratory (W) . . . 1
TE 150 Reflections on Learning . . . 3
TE 250 Human Diversity, Power, and Opportunity in Social Institutions . . . 3

b. One of the following courses (3 credits):
ABM 100 Decision-making in the Agri-Food System . . . 3
ABM 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. One of the following courses (3 credits):
CSUS 325 Study and Practice of Communication for Sustainability (W) . . . 3
CSUS 433 Grant Writing and Fund Development (W) . . . 3

e. All of the following courses for students admitted into the secondary teacher education program (15 credits):
TE 302 Learners and Learning in Contexts – Secondary (W) . . . 4
TE 407 Teaching Subject Matter to Diverse Learners – Secondary (W) . . . 5
TE 408 Crafting Teaching Practices – Secondary (W) . . . 5
TE 409 Crafting Teaching Practices in the Secondary Teaching Minor . . . 1

f. A secondary disciplinary teaching minor chosen from a list of approved secondary education minors for teacher certification. Refer to the *Teacher Certification* section of the Department of Teacher Education.

g. All of the following courses for students ***not*** pursuing secondary teacher education certification (15 credits):
CSUS 493 Professional Internship in Community Sustainability . . . 3
An additional 3 credit Community Sustainability (CSUS) course.
An additional 9 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 internships, a legacy project and study 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 330, or 433. Those courses are 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 68 credits):

			CREDITS
a.	All of the following courses:		31
	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	
	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 . . . 3	
	CSUS 310	History of Environmental Thought and Sustainability . . . 3	
	EEP 255	Ecological Economics . . . 3	
	IBIO 355	Ecology . . . 3	
b.	Two of the following courses:		6
	CSUS 215	International Development and Sustainability . . . 3	
	CSUS 265	Exploring Environmental and Sustatinability Issues and Policy with Film . . . 3	
	CSUS 273	Introduction to Travel and Tourism . . . 3	
	CSUS 276	Sustaining our National Parks and Recreation Lands . . . 3	
c.	One of the following courses:		3 or 4
	CSUS 210	Fundamentals of Soil Science . . . 3	
	GEO 206	Physical Geography . . . 3	
	GLG 201	The Dynamic Earth . . . 4	
d.	One of the following courses:		3
	CSUS 330	Organizational Management for Community Sustainability (W) . . . 3	
	CSUS 433	Grant Writing and Fund Development (W) . . . 3	
e.	One of the following courses:		3
	CSUS 464	Environmental and Natural Resource Policy in Michigan . . . 3	
	CSUS 465	Environmental and Natural Resource Law . . . 3	
	FOR 466	Natural Resource Policy . . . 3	
	IBIO 446	Environmental Issues and Public Policy . . . 3	
f.	Three of the following courses:		9 to 11
	CSUS 320	Environmental Planning and Management . . . 3	
	CSUS 354	Water Resources Management . . . 3	
	CSUS 425	Environmental Impact Assessment . . . 3	
	CSUS 426	Advanced Environmental Impact Assessment . . . 4	
	CSUS 429	Program Evaluation for Community Sustainability . . . 3	
	FW 419	Applications of Geographic Information Systems to Natural Resources Management . . . 4	
	GEO 221	Introduction to Geographic Information . . . 3	
	GEO 325	Geographic Information Systems . . . 3	
g.	One of the following courses:		3 or 4
	CSUS 322	Leadership for Community Sustainability . . . 3	
	CSUS 330	Organizational Management for Community Sustainability (W) . . . 3	
	CSUS 473	Social Entrepreneurship for Community Sustainability . . . 3	
	CSUS 476	Natural Resource Recreation Management . . . 4	
h.	One of the following courses:		3
	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 447	Community Economic Development . . . 3	
i.	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 Sustainable Parks, Recreation and Tourism

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 Sustainable Parks, Recreation and Tourism 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.

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 325, 330 or 433. 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
	CSUS	200	Introduction to Sustainability	3
	CSUS	300	Theoretical Foundations of Sustainability	3
	CSUS	301	Citizen Engagement for Sustainability	3
	CSUS	493	Professional Internship	3 to 6
b.	One of the following courses:			3
	CSUS	325	Study and Practice of Communication for Sustainability (W)	3
	CSUS	330	Organizational Management for Community Sustainability (W)	3
	CSUS	433	Grant Writing and Fund Development (W)	3
	Community Sustainability 330 may not be used to fulfill both 3. b. and 3. c.			
c.	Five of the following courses:			15 or 16
	CSUS	273	Introduction to Travel and Tourism	3
	CSUS	276	Sustaining Our National Parks and Recreation Lands	3
	CSUS	330	Organizational Management for Community Sustainability (W)	3
	CSUS	473	Social Entrepreneurship for Community Sustainability	3
	CSUS	474	Advanced Topics in Tourism Management	3
	CSUS	476	Natural Resource Recreation Management	4
	Community Sustainability 330 may not be used to fulfill both 3. b. and 3. c.			
d.	One of the following courses:			3 or 4
	FW	419	Applications of Geographic Information Systems to Natural Resources	4
	GEO	221	Introduction to Geographic Information	3
e.	Five of the following courses:			14 or 15
	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 Planning and 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 Law and Policy	3
	EEP	255	Ecological Economics	3
	FOR	412	Wildland Fire	2
	GBL	323	Introduction to Business Law	3
	HB	100	Introduction to Hospitality Business	2
	HB	237	Management of Lodging Systems	3
	HB	267	Management of Food and Beverage Systems	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	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
	ZOL	355	Ecology	3

TEACHER CERTIFICATION OPTIONS

The agriculture, food and natural resources education 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 disciplinary minor is available for teacher certification.

Students who elect the agriculture, food and natural resources education disciplinary major or the agriscience 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.

GRADUATE STUDY

The Department of Community Sustainability offers Master of Science and Doctor of Philosophy degree programs in Community Sustainability and Sustainable Tourism and Protected Area Management.

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 degree. Masters students in both 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.

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.

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.

CREDITS

Requirements for Plan A and Plan B

1. Both of the following courses (6 credits):
   CSUS 800 Foundations of Community Sustainability 3
   CSUS 802 Survey of Research Methods 3
2. A minimum of 15 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 defense of the master's 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. Both of the following courses:
   CSUS 895 Case Studies in Community Sustainability 3
   CSUS 898 Master's Professional Project 3
3. Completion and defense of a paper based on the master's professional project.

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.

Requirements for the Doctor of Philosophy Degree in Community Sustainability

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. Complete Community Sustainability 800.
2. Complete 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.
3. Complete a minimum of 24 credits of course work in two focus areas. At least 9 credits and at least one course in each focus area must be selected from Community Sustainability 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. 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 dissertation research and successfully defend the dissertation. Present the 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, Agriculture, Recreation and Resource Studies 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 (9 credits):	
CSUS 800 Foundations of Community Sustainability	3
CSUS 802 Survey of Research Methods	3
CSUS 814 Sustainable Tourism and Protected Area Management: Theories and Applications	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 (CSUS) 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. Successful completion and defense of the master's 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. Both of the following courses (6 credits):
   CSUS 895 Case Studies in Community Sustainability 3
   CSUS 898 Master's Professional Project 3
3. Completion and defense of a paper based on the master's professional project.

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. Both of the following courses (6 credits):	
CSUS 800 Foundations of Community Sustainability	3
CSUS 814 Sustainable Tourism and Protected Area Management: Theories and Applications	3
If a student already has credit in CSUS 814, these credits must be replaced by another 3 credits of research or a course relevant to one of the student's two focus areas.	
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.	
3. Complete a minimum of 21 credits in course work grouped in two focus areas each of which must have a minimum of 9 credits. Of these, at least 9 credits in total and at least one course in each focus area must be selected from Community Sustainability (CSUS) courses unless the student has previously completed a Master of Science degree 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. 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 and successfully defend the dissertation. Present the 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

F. Willian Ravlin, Chairperson

Entomology is the field of biological science concerned with the study of insects and their relatives in relation to other animals, plants, 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 broad, basic education.

UNDERGRADUATE PROGRAM

The Department of Entomology offers a Bachelor of Science degree. The program emphasizes developing strengths in the physical and biological sciences necessary to work effectively in modern entomology. Courses are designed to give the student 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

				CREDITS
Complete 15 credits from the following:				
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 of significance 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 who are enrolled in Master of Science degree programs in the Department of Entomology may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

Students enrolled in the Master of Science degree program in the Department of Entomology may elect a specialization in Ecology, Evolutionary Biology 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. For additional information 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

Scott R. Winterstein, Chairperson

The Department of Fisheries and Wildlife strongly believes that our natural resources and environment are vital to our future, thus the faculty, staff and students strive to meet the global challenges that threaten the sustainability of our ecosystems. Our students and stakeholders are empowered with the knowledge needed to ensure our natural heritage and a high quality of life. The department's mission is to provide the education, research, and outreach needed by society for the conservation and rehabilitation of fish and wildlife resources and their ecosystems. For more information visit *www.fw.msu.edu*.

UNDERGRADUATE PROGRAMS

Fisheries and wildlife management involves the maintenance and management of wild populations of fish and wildlife species and the ecosystems in which they live. Wild populations cannot be managed without an understanding of how human, social, economic, political and behavioral considerations interact in the natural world. As a fisheries and wildlife major at Michigan State University, students will acquire basic knowledge in the application of these interactions between and among the natural and social sciences.

Majors in the Department of Fisheries and Wildlife prepare for rewarding careers as fisheries and wildlife technicians, biologists, managers, naturalists, and applied ecologists. Others may choose to pursue related careers as conservation officers, environmental consultants or natural resource administrators. Employment is generally found with state and federal natural resource agencies such as the Michigan Department of Natural Resources, the U.S. Fish and Wildlife Service, and the National Park Service. There are also excellent job opportunities with private companies such as International Paper and non-profit organizations such as The Nature Conservancy or Trout Unlimited as well at many universities and colleges.

The undergraduate program in the Department of Fisheries and Wildlife at Michigan State University is nationally and internationally recognized. The program provides a strong base in the foundational and applied sciences of natural resource management. The program is designed to develop understanding of the cultural, recreational, and economic values of biological resources. The department offers a core of required courses including biology and physical sciences, math and statistics, communications, ethics and philosophy, and experiential learning in addition to a large selection of other fisheries and wildlife courses. The fisheries and wildlife undergraduate program also allows students to develop their individual interests through completion of one of six concentrations that are designed to provide additional breadth and depth, including: conservation biology, fisheries biology and management, wildlife biology and management, water sciences, fish and wildlife disease ecology and management, and preveterinary.

Conservation Biology focuses on the science of analyzing and protecting the earth's biological diversity drawing from the biological, physical and social sciences, economics, and the practice of natural resource management.

Fisheries Biology and Management is designed for students interested in the research and management of fish, other freshwater and marine organisms, and the ecosystems that sustain them.

Wildlife Biology and Management is for students interested in understanding and managing terrestrial habitats and animals including game, non-game, and endangered species.

Water Sciences 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 including water quality. This concentration provides students with an understanding for protecting and restoring water resources around the Great Lakes and the world.

Fish and Wildlife Disease Ecology and Management is designed to provide students with an improved understanding of the emergence and spread of infectious diseases and the likely consequences that increased contact between fish and wildlife, and domestic animal and human populations have on these environmental problems.

Preveterinary is designed for students who are interested in careers in veterinary medicine and satisfies the course requirements for admission to Michigan State University's College of Veterinary Medicine. Dual advising at the College of Veterinary Medicine is required.

Students who complete the requirements for the fisheries and wildlife major and choose elective courses appropriately can also satisfy requirements for certification by: the American Fisheries Society as an Associate Fisheries Scientist; by the Wildlife Society as an Associate Wildlife Biologist; or the Society of Wetland Scientists as a Wetland Professional-in-training.

Students who are enrolled in the Bachelor of Science degree in Fisheries and Wildlife may elect to minor in any number of related relevant subject areas. For additional information available on minors, visit *http://www.reg.msu.edu/AcademicPrograms/Programs.asp?PType=MNUN.*

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) BS 161 Cell and Molecular Biology . . . 3
     BS 171 Cell and Molecular Biology Laboratory . . . 2
     LB 144 Biology I - Organismal Biology . . . 4
   - (3) LB 144 Biology I – Organismal Biology . . . 4
     LB 145 Biology II: Cellular and Molecular Biology . . . 5

   Students pursuing the Preveterinary concentration must complete either group (2) or group (3).

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
     ENT 319 Introduction to Earth System Science . . . 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 325 Study and Practice of Communication for Sustainability (W) . . . 3
   - CSUS 433 Grant Writing and Fund Development (W) . . . 3
   - FW 435 Integrated Communications for the Fisheries and Wildlife Professional . . . 3
   - JRN 472 Laboratory in Environmental Reporting . . . 3
   - WRA 320 Technical Writing (W) . . . 3
   - WRA 331 Writing in the Public Interest (W) . . . 3
   - WRA 341 Nature, Environmental, and Travel Writing . . . 3
   - WRA 453 Grant and Proposal Writing . . . 3

f. One of the following courses (3 credits):
   - FW 438 Philosophy of Ecology (W) . . . 3
   - FW 439 Conservation Ethics . . . 3
   - PHL 340 Ethics . . . 3
   - PHL 342 Environmental Ethics . . . 3
   - PHL 380 Nature of Science . . . 3
   - PHL 484 Philosophy of Biological Science . . . 3
   - GEO 432 Environmental Ethics (W) . . . 3

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

FW 443 Restoration Ecology 3
ZOL 445 Evolution (W). 3

(2) One of the following courses (3 credits):
FOR 404 Forest Ecology 3
PLB 441 Plant Ecology 3
ZOL 485 Tropical Biology 3

(3) One of the following courses (3 or 4 credits):
CSS 350 Introduction to Plant Genetics 3
ZOL 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 Law and Policy 3
EEP 255 Ecological Economics 3
FW 481 Global Issues in Fisheries and Wildlife 3
FOR 466 Natural Resource Policy 3
MC 450 International Environmental Law and Policy . . 3
ZOL 446 Environmental Issues and Public 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
PLB 218 Plants of Michigan 3
PLB 418 Plant Systematics 3
ZOL 360 Biology of Birds 4
ZOL 365 Biology of Mammals 4
ZOL 384 Biology of Amphibians and Reptiles (W). 4

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
ZOL 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
ZOL 328 Comparative Anatomy and Biology of Vertebrates (W). 4
ZOL 341 Fundamental Genetics 4
ZOL 483 Environmental Physiology (W) 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):
ZOL 360 Biology of Birds 4
ZOL 365 Biology of Mammals 4
ZOL 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 335 Plants Through Time. 3
PLB 441 Plant Ecology 3

(5) One of the following courses (3 or 4 credits):
CSS 350 Introduction to Plant Genetics 3
ZOL 328 Comparative Anatomy and Biology of Vertebrates (W). 4
ZOL 341 Fundamental Genetics 4
ZOL 483 Environmental Physiology (W) 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
ZOL 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
ZOL 303 Oceanography. 4
ZOL 341 Fundamental Genetics 4
ZOL 353 Marine Biology (W) 4
ZOL 483 Environmental Physiology (W) 4

Fish and Wildlife Disease Ecology and Management
(33 to 35 credits):

(1) All of the following courses (24 credits):
EPI 390 Disease in Society: Introduction to Epidemiology and Public Health 4
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
MMG 301 Introductory Microbiology 3
ZOL 341 Fundamental Genetics 4
ZOL 445 Evolution (W). 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 (3 or 4 credits):
FW 471 Ichthyology 4
ZOL 306 Invertebrate Biology 4
ZOL 316 General Parasitology. 3
ZOL 360 Biology of Birds 4
ZOL 365 Biology of Mammals 4
ZOL 384 Biology of Amphibians and Reptiles (W). 4

Preveterinary (38 or 39 credits):

(1) All of the following courses (31 credits):
BMB 401 Basic 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
MMG 301 Introductory Microbiology 3
MMG 302 Introductory Laboratory for General and Allied Health Microbiology. 1
MMG 409 Eukaryotic Cell Biology 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 (4 credits):
ANS 314 Genetic Improvement of Domestic Animals . . 4
ZOL 341 Fundamental Genetics 4

(3) One of the following courses (3 or 4 credits):
ANS 313 Principles of Animal Feeding and Nutrition . . . 4
HNF 150 Introduction to Human Nutrition 3
HNF 260 Principles of Human Nutrition 3

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	3
	FW	445	Biodiversity Conservation Policy and Practice	3
	MC	450	International Environmental Law and Policy	3
	SOC	452	Environment and Society	3
	ZOL	446	Environmental Issues and Public Policy	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
FW	110	Conservation and Management of Marine Resources		3
FW	416	Marine Ecosystem Management		3
ZOL	303	Oceanography		4
ZOL	353	Marine Biology (W)		4
Biodiversity				
One of the following courses:				4
FW	471	Ichthyology		4
PLB	424	Algal Biology		4
ZOL	306	Invertebrate Biology		4
Experiential Learning in Marine Ecosystem Management				
One of the following courses which must contain a marine emphasis:				2 to 4
FW	480	International Studies in Fisheries and Wildlife		3
FW	493	Professional Internships in Fisheries and Wildlife		2 or 3
ZOL	496	Internship in Zoology		4
ZOL	498	Internship in Zoo and Aquarium Science		4

GRADUATE STUDY

The graduate program in the Department of Fisheries and Wildlife at Michigan State University is nationally and internationally recognized as a leader in research and teaching. Our faculty are among the top professionals in their fields, and our programs are at the forefront of teaching management policy, conservation biology, human dimensions of natural resources management, as well as fish and wildlife biology, ecology, and management.

Scientists from throughout the world regularly visit the department, interacting with the faculty and students, and presenting seminars. Graduate students are encouraged to attend regional, national, and international professional meetings such as the annual Midwest Fish and Wildlife Conference, the American Fisheries Society Conference, the Wildlife Society Conference, the North American Wildlife and Natural Resources Conference, the Society for Conservation Biology Conference, Ecological Society of American Conference, and the International Association of Landscape Ecology Conference in addition to local professional meetings such as the Michigan Chapters of the American Fisheries Society and The Wildlife Society.

The Department of Fisheries and Wildlife brings together a diverse group of related basic and applied sciences. Faculty and graduate students are actively engaged in teaching, research, and outreach. Major areas of interest include: wildlife ecology and management; fisheries science and management; limnology (including water quality and water pollution biology); conservation biology; environmental management; aquaculture; human dimensions of resource management; wetland ecology and management; stream ecology; wildlife disease ecology and conservation medicine; and ecosystem and population modeling.

In addition to the major areas of interest, fisheries and wildlife graduate students can develop their own program of study under the direction of major professors and guidance committees within the department. For students who wish to pursue programs in the social, economic, geographic, or education-related aspects of

fisheries and wildlife management, interdisciplinary programs are offered. Interaction with many related departments and colleges at Michigan State University, as well as with state and federal agencies, allow for both depth and breadth in research and academic programs.

The Department of Fisheries and Wildlife offers Master of Science and Doctor of Philosophy degree programs in fisheries and wildlife, a Doctor of Philosophy degree program in fisheries and wildlife—environmental toxicology, and a Graduate Certificate in Conservation Law.

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.

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 graduate programs in fisheries and wildlife are designed to provide:

1. Broad fundamental preparation in the ecological sciences.
2. Preparation in one of the areas of specialization within the field of fisheries and wildlife.
3. A foundation for careers in administration, research, management, teaching, or extension.

The department offers the following areas of specialization within the field of fisheries and wildlife: conservation biology, restoration ecology, human dimensions, fisheries ecology and management, wildlife ecology and management, population dynamics and modeling, limnology, aquaculture, environmental management, environmental education, and environmental toxicology.

In cooperation with other colleges and departments, graduate students in the Department of Fisheries and Wildlife may be involved in research in the nutrition, pathology, and physiology of fish and wildlife.

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. The Subject Test in Biology is recommended.

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 courses related to one of the areas of specialization within the field of fisheries and wildlife referenced above and three credits of Fisheries and Wildlife 893. The program must be approved by the student's guidance committee.

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 and a Master of Science degree in a biological or other appropriate science. Additional background in mathematics, chemistry, botany, and zoology is desirable. Scores on the Graduate Record Examination General Test are required. The Subject Test in Biology is recommended.

Requirements for the Doctor of Philosophy Degree in Fisheries and Wildlife

The student and the major professor plan a program of study that includes courses related to one of the areas of specialization within the field of fisheries and wildlife referenced above and three credits of Fisheries and Wildlife 893. The program must be approved by the student's guidance committee.

FISHERIES AND WILDLIFE— ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in fisheries and wildlife—environmental toxicology, refer to the statement on *Doctoral Program in Environmental and Integrative Toxicological Sciences* in the *Graduate Education* section of this catalog.

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

Frederik Derksen, 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, and food security.

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 Dietetic's 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 Dietetic 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, or ACEND-approved Accredited Coordinated Program. Dietetic registration, as administered by the Commission on Dietetic Registration, is a requirement of most positions for professional dietitians.

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 300, 471 and 472. Those courses are 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:	42
	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	4
	HNF 400 Art and Science of Food Preparation	2
	HNF 406 Global Foods and Culture	3
	HNF 440 Foodservice Operations	3
	HNF 444 The Business of Nutrition Services	3
	HNF 445 Foodservice Management Practicum	2
	HNF 453 Nutrition and Human Development	3
	HNF 471 Medical Nutrition Therapy I	4
	HNF 472 Medical Nutrition Therapy II	4
b.	The following courses outside the Department of Food Science and Human Nutrition:	39 to 42
	(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
	(4) The following course (3 credits):	
	CSE 101 Computing Concepts and Competencies	3
	Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.	

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 universities 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.

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.

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 231. The completion of Chemistry 161 and 162 satisfies the laboratory requirement. Biological Science 161, Chemistry 161 and 162 and Physics 231 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:

				CREDITS
a.	All of the following courses:			54
	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	325	Food Processing: Unit Operations	3
	FSC	401	Food Chemistry	3
	FSC	402	Food Chemistry Laboratory	1
	FSC	422	Advanced Professional Seminar in Food Science	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
	PHY	231	Introductory Physics I	3
b.	One of the following courses (3 credits):			
	FSC	430	Food Processing: Fruits and Vegetables	3
	FSC	431	Food Processing: Cereals	3
c.	One of the following courses (3 credits):			
	FSC	432	Food Processing: Dairy Foods	3
	FSC	433	Food Processing: Muscle Foods	3
d.	*One* of the following concentrations:			23 to 26

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) Nine 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
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	232	Introductory Physics II	3

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):

ABM	100	Decision-making in the Agri-Food System	3
ABM	222	Agribusiness and Food Industry Sales (W)	3
ABM	435	Financial Management in the Agri-Food System	3
FI	311	Financial Management	3
FIM	335	Food Marketing Management	3
MKT	302	Consumer and Organizational Buyer Behavior	3

Either Finance 311 *or* Agribusiness Management 435, but not both of those courses, may be used to satisfy requirement (2) for the **Food Business and Industry** concentration.

Food Packaging (26 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	3
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) Nine 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	430	Food Processing: Fruits and Vegetables	3
FSC	431	Food Processing: Cereals	3
FSC	432	Food Processing: Dairy Foods	3
FSC	421	Food Laws and Regulations	3
FSC	433	Food Processing: Muscle Foods	3
FSC	481	Fermented Beverages	3
HB	100	Introduction to Hospitality Business	2
HB	265	Food Management: Safety and Nutrition	3
HB	267	Management of Food and Beverage Systems	3
HB	409	Introduction to Wine	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	2
		HNF	250L	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	4
	(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	185L	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 490, HNF 490H, HNF 494 or any approved study abroad, service, or research experience.			
b.	One of the following concentrations:				
	Biomedical and Molecular Nutrition (40 to 50 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) or (b) (8 credits):			
		(a) LB	273	Physics I	4
		LB	274	Physics II	4
		(b) 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
	(3)	All of the following courses (11 credits):			
		CEM	251	Organic Chemistry I	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	4
		(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	408	Histology	4
		MMG	301	Introductory Microbiology	3
		MMG	409	Eukaryotic Cell Biology	3
		PHM	350	Introductory Human Pharmacology	3
		PSY	320	Health Psychology	3
	Global Nutrition and Health (42 to 47 credits):				
	(1)	All of the following courses (20 credits):			
		CSUS	215	International Development and Sustainability	3
		HNF	377	Applied Community Nutrition	4
		HNF	406	Global Foods and Culture	3
		HNF	453	Nutrition and Human Development	3
		PSL	310	Physiology for Pre-Health Professionals	4
		SOC	362	Developing Societies	3
	(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 (2 to 4 credits):			
		AL	200	Cultural Difference and Study Abroad	3
		ANP	200	Navigating Another Culture	2
		ANP	370	Culture, Health, and Illness	3
		COM	391	Topics in Verbal, Intercultural, or Gender Communication	4
		GSAH	230	Values, Experience, and Difference in Global Contexts	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 (W)	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)	Two of the following courses (6 credits):			
		ANP	270	Women and Health: Anthropological and International Perspectives	3
		CSS	431	International Agricultural Systems	3
		CSUS	463	Food Fight: Politics of Food	3
		EEP	260	World Food Population and Poverty	3
		FOR	466	Natural Resource Policy	3
		GEO	435	Geography of Health and Disease	3

PHL 453 Ethical Issues in Global Public Health 3
SOC 161 International Development and Change 3

Public Health Nutrition (40 to 43 credits):

(1) All of the following courses (23 credits):
HM 101 Introduction to Public Health 3
HNF 377 Applied Community Nutrition. 4
HNF 385 Public Issues in Health and 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 (W) . . . 3

(5) Two of the following courses (6 or 7 credits):
ANP 270 Women and Health: Anthropological and International Perspectives. 3
ANP 370 Culture, Health, and Illness 3
ANP 443 Human Adaptability 3
EPI 240 Epidemiological Investigations in Nutrition and Health. 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
PHL 453 Ethical Issues in Global Public Health. 3
PLS 313 American Public Policy 3
SOC 451 Dynamics of Population 3
SOC 461 Basic Demographic Techniques and Applications. 3
SOC 475 Health and Society 3

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 and Molecular Genetics 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
	ANS	201	Animal Products 3	
	FSC	211	Principles of Food Science 3	
2.	The following course:			3
	FSC	325	Food Processing: Unit Operations 3	
3.	Two of the following courses:			5 or 6
	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
	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 Doctor of Philosophy degree program with a major in food science—environmental toxicology. Those programs are described below. The department also offers Master of Science and Doctor of Philosophy degree programs with majors in human nutrition and a Doctor of Philosophy degree program with a major in human nutrition-environmental toxicology. 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 where appropriate 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 degree programs in the Department of Food Science and Human Nutrition may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

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

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 and doctoral degree programs in food science must meet the requirements specified below.

A student who is admitted to a graduate program in food science is expected to have general, quantitative, and organic chemistry and biochemistry. In addition, preparation for graduate work should include courses in the biological and agricultural sciences, mathematics, physics, nutrition, engineering, or economics. A student with insufficient academic background may be required to complete collateral courses in addition to the courses that are required for the degree.

For the master's degree in food science, 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.

FOOD SCIENCE—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in food science—environmental toxicology, refer to the statement on *Doctoral Program in Environmental and Integrative Toxicological Sciences* in the *Graduate Education* section of this catalog.

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 scores on the Graduate Record Examination General Test;
5. 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 . . . 2
   - HNF 823 Research Methods in Human Nutrition . . . 1
   - HNF 824 Nutrition Policies and Programs . . . 1
   - HNF 825 Nutritional Immunology . . . 1
   - HNF 826 Obesity and Chronic Disease . . . 1
   - HNF 892 Nutrition Seminar . . . 1
2. A minimum of 10 credits (Plan A) or 20 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.

Additional Requirements for Plan B

1. Completion of a final examination or evaluation.

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 scores on the Graduate Record Examination General Test;
5. 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 . . . 2
   - HNF 823 Research Methods in Human Nutrition . . . 1
   - HNF 824 Nutrition Policies and Programs . . . 1
   - HNF 825 Nutritional Immunology . . . 1
   - HNF 826 Obesity and Chronic Disease . . . 1
   - HNF 892 Nutrition Seminar . . . 2
2. 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.
3. Complete 24 credits of course work in HNF 999 Doctoral Dissertation Research.
4. Successfully defend the doctoral dissertation.

HUMAN NUTRITION—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in human nutrition–environmental toxicology, refer to the statement on *Doctoral Program in Environmental and Integrative Toxicological Sciences* in the *Graduate Education* section of this catalog.

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 Urban and Community Forestry. Students who are not majoring in Forestry can minor in Forestry or Forestry Field Applications.

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.

Students who are enrolled in the Bachelor of Science degree program with a major in Forestry may also elect a specialization in agricultural and natural resources biotechnology. For additional information, refer to the *Specialization in Agricultural and Natural Resources Biotechnology* statement.

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. 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, often in international settings. Forest professionals work with the Peace Corps and other international development organizations in reforestation projects. There are also rewarding careers for forestry professionals in urban and suburban settings, with municipal forestry organizations or with private tree and shrub-care companies in promoting green, sustainable, and livable environments. The high quality education afforded by the bachelor's degree provides the knowledge and skills needed for the career opportunities listed above, and many others, as well as the rigorous background needed for graduate studies in forestry and related fields, including ecology, soil science, environmental science, geography, economics, social science, public policy, and law.

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, 404L, 405, 406L, 414, and 462. 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:.	61
	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	Seminar on Contemporary Issues in Forests and the Environment	1
	FOR	204	Forest Vegetation	3
	FOR	222	Forestry Field Methods	2
	FOR	330	Human Dimensions of Forests	3
	FOR	404	Forest Ecology	3
	FOR	404L	Forest Ecology Laboratory	1
	FOR	405	Forest Ecosystem Services	3
	FOR	406	Applied Forest Ecology: Silviculture	3
	FOR	406L	Applied Forest Ecology: Silviculture Laboratory	1
	FOR	412	Wildland Fire	2
	FOR	414	Renewable Wood Products	3
	FOR	420	Forestry Field Studies	3
	FOR	462	Forest Resource Economics and Management	4
	FOR	466	Natural Resource Policy	3
	FOR	472	Ecological Monitoring and Data Analysis	3
	FW	419	Applications of Geographic Information Systems to Natural Resources	4
	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 Ecosystem Management	3
	FW	443	Restoration Ecology	3
	FW	444	Conservation Biology	3
e.	One of the following courses (3 credits):			
	WRA	320	Technical Writing (W)	3
	WRA	331	Writing in the Public Interest (W)	3
	WRA	341	Nature, Environmental, and Travel Writing	3
	WRA	453	Grant and Proposal Writing	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

				CREDITS
Students must complete the following requirements (16 to 19 credits):				
1.	All of the following courses (8 credits):			
	FOR	204	Forest Vegetation	3
	FOR	222	Forestry Field Methods	2
	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 or 4 credits):			
	FOR	405	Forest Ecosystem Services	3
	FOR	414	Renewable Wood Products	3
	FOR	462	Forest Resource Economics and Management	4
	FOR	466	Natural Resource Policy	3
4.	One of the following courses covering biological aspects of Forestry (2 to 4 credits):			
	FOR	404	Forest Ecology	3
			And	
	FOR	404L	Forest Ecology Laboratory	1
	FOR	406	Applied Forest Ecology: Silviculture	3
			And	
	FOR	406L	Applied Forest Ecology: Silviculture Laboratory	1
	FOR	412	Wildland Fire	2
	PLP	407	Diseases and Insects of Forest and Shade Trees	4

MINOR IN FORESTRY FIELD APPLICATIONS

The Minor in Forestry Field Applications is designed to serve students who desire additional training in field biology as it relates to the management of forested 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 Field Applications

Complete all of the following courses (16 credits):

			CREDITS
FOR	204	Forest Vegetation	3
FOR	222	Forestry Field Methods	2
FOR	404	Forest Ecology	3
FOR	404L	Forest Ecology Laboratory	1
FOR	406	Applied Forest Ecology: Silviculture	3
FOR	406L	Applied Forest Ecology: Silviculture Laboratory	1
FOR	420	Forestry Field Studies	3

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 (20 to 22 credits):				
1.	All of the following courses (8 credits):			
	FOR	222	Forestry Field Methods	2
	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):			
	CSUS	301	Community Engagement for Sustainability	3
	FOR	330	Human Dimensions of Forests	3
	FOR	405	Forest Ecosystem Services	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	404	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):			
	CSUS	433	Grant Writing and Fund Development (W)	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 Doctor of Philosophy degree program in forestry—environmental toxicology and 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*.

FORESTRY

Master of Science

The Master of Science degree may be earned either in a professional program in forest management or administration or in a forestry specialty program.

The professional program in forest management or administration is viewed as an extension of general forestry, and, therefore, requires a bachelor's degree with a major in forestry as a prerequisite or a collateral program of study in undergraduate forestry courses. There is, however, considerable flexibility in the program to meet individual student needs and objectives.

A forestry specialty program, on the other hand, is as readily open to nonforesters as to foresters. It includes some forestry courses but draws mainly from other departments in the university to provide courses appropriate to forestry specialties: forest biometrics, tree physiology, forest soils, forest recreation, forest management, forest business management, forest economics, forest influences, forest ecology, forest genetics, forest entomology, forest hydrology, and wood science and technology.

Qualified students with undergraduate degrees in forestry can usually complete the requirements for the Master of Science degree in forestry in one year. The student must meet the requirements of the university and of the College of Agriculture and Natural Resources. The student must also complete additional requirements for the program as specified by the student's academic advisor. 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.

Doctor of Philosophy

The Doctor of Philosophy degree program with a major in forestry is open to nonforesters as well as foresters. Forestry specialties are studied in depth.

Qualified students with undergraduate degrees in forestry can usually complete the requirements for the Doctor of Philosophy degree in forestry in six semesters. The student must meet the requirements of the university and of the College of Agriculture and Natural Resources. The student must also complete additional requirements for the program as specified by the student's academic advisor.

Program requirements are highly variable, depending on the student's background of study and experience. In all cases, the student must complete an acceptable dissertation incorporating the results of original research.

FORESTRY—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in forestry—environmental toxicology, refer to the statement on *Doctoral Program in Environmental and Integrative Toxicological Sciences* in the *Graduate Education* section of this catalog.

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.

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 University was established in 1883 as the first university horticulture department in the United States, and remains a leader in the field and the industry to this day. Horticulture is a complex and diversified, yet fully integrated discipline that encompasses the biological, molecular and physical sciences, business management, and the arts. Horticulturists work to improve the production of nutritious, high-quality and safe food, advance the development and use of new specialty 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 plant scientists, growers, consumers, society and the environment.

For students seeking a bachelor's degree, we offer concentrations in horticultural science; sustainable and organic horticulture; and landscape design, construction and management. Additionally, multiple two-year certificate programs are offered both on-campus in East Lansing, as well as off-campus in Northwest, West, and Southwest Michigan. The two-year programs offer a fast track for students interested in the landscape, nursery, greenhouse, fruit, vegetable, and organic horticulture industries. All of 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 extensively involved in professional and social activities beyond the classroom and design studio: gaining experience in research laboratories; assisting in field-based projects; managing the Horticulture Association spring show and plant sale; working with the Ecological Food and Farm Stewardship Club; and training for and participating in academic and field events associated with the National Collegiate Landscape Competition.

Our facilities include classroom and laboratories that are 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 Student Organic Farm is located at the HTRC where students gain practical, non-credit experiences and produce food for a Community Supported Agriculture program as well as MSU's residential housing service.

UNDERGRADUATE PROGRAM

Horticulture is the science and art concerned with the culture, production, marketing, and utilization of high–value intensively cultivated plants. Horticultural crops are diverse, including annual and perennial species, food and ornamental plants, and plants grown outdoors and in controlled environments. Horticultural foods and food products, flowers, and landscapes sustain and enrich our lives. The primary horticulture discipline areas include floriculture, landscape horticulture, olericulture (vegetables), and pomology (fruits).

Graduates with a major in horticulture may enter a broad range of challenging and rewarding professional careers in production, management, marketing, education, consulting and service industries, or research. 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 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, plant physiology, entomology, and plant pathology), environmental science (soil science), with horticultural crop production, and business (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 Horticulture Landscape Design, Construction, and Management. In all concentrations, students obtain hands–on experiences through laboratory exercises in the greenhouses, in the horticulture gardens, or at the farms. Field trips expose students to successful horticultural businesses, industries, and support services within Michigan. Students may gain professional work experience through internships, independent study, and part–time employment in research and extension programs within the Department of Horticulture.

Students who are enrolled in the Bachelor of Science degree program with a major in horticulture may elect a Specialization in Agricultural and Natural Resources Biotechnology. For additional information, refer to the *Specialization in Agricultural and Natural Resources Biotechnology* statement.

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:. 34

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
HRT	203	Principles of Horticulture 3
HRT	204	Plant Propagation 2
HRT	205	Plant Mineral Nutrition. 1
HRT	206	Training and Pruning Plants 1
HRT	207	Horticulture Career Development 1
HRT	361	Applied Plant Physiology. 3
HRT	362	Applied Crop Improvement 1
HRT	404	Horticulture Management (W). 3
HRT	493	Professional Internship in Horticulture 3
PLB	105	Plant Biology 3
PLB	106	Plant Biology Laboratory 1

b. One of the following concentrations:. . . . . 33 to 37

Horticultural Science (33 credits):

(1) All of the following courses (12 credits):

CSS	350	Introduction to Plant Genetics 3
ENT	404	Fundamentals of Entomology 3
HRT	221	Greenhouse Structures and Management . . . 3
PLP	405	Plant Pathology 3

(2) Complete 9 credits from the following:

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	341	Vegetable Production and Management. 3

(3) Complete 3 credits from the following:

CSS	288	Principles of Weed Management 3
HRT	211	Landscape Plants I 3
HRT	212	Landscape Plants II. 3
HRT	218	Irrigation Systems for Horticulture. 3
HRT	242	Passive Solar Greenhouses for Protected Cultivation 1
HRT	243	Organic Transplant Production 1
HRT	253	Compost Production and Use 1
HRT	475	International Studies in Horticulture 3

(4) Three of the following courses (9 credits):

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 (31 credits):

(1) All of the following courses (13 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. 3

(2) Complete 9 credits from the following:

CSS	288	Principles of Weed Management 3
HRT	221	Greenhouse Structures and Management . . . 3
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	475	International Studies in Horticulture 3
HRT	490	Independent Study . . . . . 1 or 2

(3) Three of the following courses (9 credits):

CSS	451	Biotechnology Applications for Plant Breeding and Genetics 3
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 (37 credits):

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

CSS	202	The World of Turf 2
HRT	211	Landscape Plants I 3
HRT	212	Landscape Plants II. 3
HRT	218	Irrigation Systems for Horticulture. 3
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 15 credits from the following:

CSS	288	Principles of Weed Management 3
LA	140	Graphics and Two-Dimensional Design Studio 4
LA	230	Site Construction Materials and Methods 4
HRT	213	Landscape Maintenance 2
HRT	213L	Landscape Maintenance Field Laboratory . . . 1
HRT	214	Landscape and Turfgrass Business Operations. 2
HRT	219	Landscape Computer Aided Design 2
HRT	220	Annual and Aquatic Landscape Plants 3
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	415	Natural Landscapes, Native Plants, and Landscape Restoration 3
HRT	460	Green Roofs and Walls 1
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 adviser in Horticulture.

Requirements for the Minor in Horticulture

CREDITS

Complete 17 credits from the following:

1. Both of the following courses (5 credits):

HRT	203	Principles of Horticulture 3
HRT	204	Plant Propagation 2

2. Complete 12 credits from the following:

HRT	205	Plant Mineral Nutrition. 1
HRT	206	Training and Pruning Plants 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. 3
HRT	219	Landscape Computer Aided Design 2
HRT	220	Annual and Aquatic Landscape Plants 3
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	362	Applied Crop Improvement 1
HRT	403	Handling and Storage of Horticultural Crops. 3
HRT	407	Horticulture Marketing 3
HRT	411	Landscape Contract Management 3
HRT	415	Natural Landscape, Native Plants, and Landscape Restoration 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 Doctor of Philosophy and Master of Science degrees in horticulture, plant breeding, and genetics and biotechnology - horticulture. Faculty members in the Department of Horticulture possess an array of interdisciplinary plant science expertise ranging from breeding, genetics, genomics, molecular biology, bioinformatics, and biochemistry, to developmental/environmental/reproductive physiology, sustainable and organic cropping systems, and marketing of horticultural/specialty crops. These integrated approaches foster new discoveries in the plant sciences and technological innovations in the sustainable production of food, floral, and landscape crops. Faculty and graduate students engage in scholarly research, teaching, and outreach programs that are recognized nationally and internationally by our peer institutions and horticultural industries. Numerous fellowships and grant-funded assistantships are available on a career interest and competitive basis. Contact faculty members directly to explore the potential to earn an advanced degree working in their research and outreach programs.

Students who are enrolled in Master of Science degree programs in the Department of Horticulture may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

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

Susan E. Selke, 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. Two concentrations are offered: Packaging Science and Packaging Value Chain Management. The Packaging Science concentration focuses on the technical needs of packaging while the Packaging Value Chain Management concentration focuses on the role of packaging in the value chain and the need to understand economics and business functions. Elective courses provide focused study in specific areas of the packaging industry.

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 486. 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:			57
	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	485	Packaging Development	3
	PKG	486	Packaging Senior Capstone (W)	3
	PHY	231	Introductory Physics I	3
	PHY	232	Introductory Physics II	3
b.	One of the following courses:			3
	FSC	342	Food Safety and Hazard Analysis Critical Control Point Program	3
	MMG	201	Fundamentals of Microbiology	3
	A course used to fulfill this requirement may not be used to fulfill a requirement in the Packaging Science concentration.			
c.	One of the following courses:			3 or 4
	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
	MKT	327	Introduction to Marketing	3
	SCM	303	Introduction to Supply Chain Management	3
	A course used to fulfill this requirement may not be used to fulfill a requirement in the Packaging Value Chain Management concentration.			

e. One of the following concentrations (18 credits):

Packaging Science

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

PKG	452	Medical Packaging	4
PKG	455	Food Packaging	3

2. Completion of 6 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.
3. Completion of 9 credits of electives from the following with at least one course at the 300-level or above:

BMB	200	Introduction to Biochemistry	4
CE	221	Statics	3
FSC	211	Principles of Food Science	3
FSC	325	Food Processing: Unit Operations	3
FSC	342	Food Safety and Hazard Analysis Critical Control Point Program	3
FSC	401	Food Chemistry	3
FSC	421	Food Laws and Regulations	3
FSC	440	Food Microbiology	3
MMG	201	Fundamental of Microbiology	3
MMG	301	Introductory Microbiology	3
MMG	302	Introductory for General and Allied Health Microbiology	1
STT	464	Statistics for Biologists	3
STT	465	Bayesian Statistical Methods	3

Other courses with department approval.

Courses used to fulfill a concentration requirement may not be used to fulfill requirement 3. b. above.

Packaging Value Chain Management

1. The following course (3 credits):
   PKG 465 Packaging Value Chain 3
2. Completion of 6 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 requiremement with advisor approval.
3. Completion of 9 credits of electives from the following:

EC 301 Intermediate Microeconomics 3
EC 302 Intermediate Macroeconomics 3
EC 360 Private Enterprise and Public Policy 3
FI 320 Introduction to Finance 3
GBL 323 Introduction to Business Law 3
MGT 325 Management Skills and Processes 3
MKT 327 Introduction to Marketing. 3
SCM 303 Introduction to Supply Chain Management 3
Other courses with department approval.
Courses used to fulfill a concentration requirement may not be used to fulfill requirement 3. d. above.

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.

Students who are enrolled in Master of Science degree programs in the School of Packaging may elect a Graduate Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

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

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.
2. A grade–point average of at least 3.40 for the 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:

1. Complete both of the following courses:

			CREDITS
PKG	860	Research Methods	3
PKG	985	Analytical Solutions to Packaging Design	3

2. Complete additional 800–900 level courses related to the student's dissertation research as specified by the student's guidance committee.
3. Pass both a written and an oral comprehensive examination.
4. Complete a dissertation in one of the following areas of packaging: material science applications in packaging, food packaging, healthcare packaging, mass transport applications, dynamics and physical distribution aspects or human factors in packaging.

SCHOOL of PLANNING, DESIGN and CONSTRUCTION

Scott T. Loveridge, Acting 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 junior-level 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 overall grade point average.

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
Or			
STT	315	Introduction Probability and Statistics for Business	3
Or			
STT	421	Statistics I	3
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	211	Building Codes	3
CMP	222	Statics and Strengths of Materials	3
CMP	230	Utility Systems	4

3. Have either a cumulative grade-point average of 3.00 in the CMP courses listed in item 2. or a cumulative MSU grade-point average of 3.00.

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 work experience, personal experience, and diversity 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 or 435 or 436. Those courses are referenced in item 3. b. 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 Biological and Physical Sciences that consists of Physics 231 and 251 *and* one of the following choices: Biological Science 161 and 171 or Biological Science 162 and 172 *or* Plant Biology 105 and 106 *or* Microbiology and Molecular Genetics 205 and 206. The completion of Physics 251 *and* Biological Science 171 or 172 *or* Plant Biology 106 *or* Microbiology and Molecular Genetics 206 satisfies the laboratory requirement. With advisor approval, for this laboratory requirement, Biological Science 171 or 172, Plant Biology 106 and Microbiology and Molecular Genetics 206 may be waived if the student completes another chemistry laboratory course or a physics laboratory course beyond Physics 251.

   Physics 231 and 251 and Biological Science 161 and 171 or 162 and 172 or Plant Biology 105 and 106 or Microbiology and Molecular Genetics 205 and 206 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:

				CREDITS
a.	All of the following courses:			64
	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	211	Building Codes	3
	CMP	230	Utility Systems	4
	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	4
	CMP	328	Construction Presentation Graphics and Building Information Modeling	2
	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
	COM	100	Human Communication	3
	CSE	101	Computing Concepts and Competencies	3
	GBL	323	Introduction to Business Law	3
	MTH	124	Survey of Calculus I	3
	PHY	231	Introductory Physics I	3
	PHY	251	Introductory Physics Laboratory I	1
	Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.			
	Students must have a minimum grade-point of 2.00 in each of the following courses: CMP 305, 311, 315, 322, 325, 328, 385, 401, 415, and 423.			
b.	One of the following courses (3 credits):			
	CE	221	Statics	3
	CMP	222	Statics and Strengths of Materials	3
c.	One of the following courses (3 or 4 credits):			
	CE	312	Soil Mechanics	4
	CE	471	Construction Engineering - Equipment, Methods and Planning	3
	CMP	453	Land Development	3
	CMP	491	Special Topics in Construction Management	3
	IDES	240	Computer-Aided Design for Designers	3
	LA	230	Site Construction Materials and Methods	3
	PDC	491	Special Topics	3
	UP	458	Housing and Real Estate Development	3
d.	One of the following courses:			3
	CMP	435	Residential Building and Development Projects (W)	3
	CMP	436	Commercial Building Projects (W)	3
	CMP	492	Capstone Project Competitions	3
	CMP	493	Professional Internship in Building Construction Management	3
e.	Complete four credits from the following courses:			4
	CEM	141	General Chemistry	4
	CEM	161	Chemistry Laboratory I	1
	PHY	232	Introductory Physics II	3
	PHY	252	Introductory Physics Laboratory II	1
f.	Complete one of the following courses:			3 or 4
	COM	225	An Introduction to Interpersonal Communication	3
	COM	240	Introduction to Organizational Communication	4
	ENG	226	Introduction to Creative Writing	3
	ENG	232	Writing as Exploration	3
g.	One of the following courses:			3 or 4
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	315	Introduction to Probability and Statistics for Business	3
	STT	421	Statistics I	3
h.	One of the following courses:			3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
i.	One of the following courses:			3
	FI	320	Introduction to Finance	3
	MKT	327	Introduction to Marketing	3
	SCM	303	Introduction to Supply Chain Management	3
j.	Complete the following course:			3
	MGT	325	Management Skills and Processes	3

INTERIOR DESIGN

This major provides academic preparation designed to enable the graduate to enter the profession of interior design. The program has been accredited by the Council for Interior Design Accreditation (CIDA).

Emphasis is placed on learning the means of satisfying functional and aesthetic requirements appropriate for a variety of specific interior spatial uses. Consideration is given to the human being and the micro–environment in the total complex of environmental relationships. The combination of courses and experiences provides students an opportunity to develop knowledge, skills, and insights needed to solve design problems creatively and effectively.

Students meeting the university admissions requirements are enrolled as freshmen and sophomores in the Neighborhood Student Success Collaborative but may declare a major preference for Interior Design.

Admission as a Junior

The number of students admitted as juniors to the major in interior design is limited. To be considered for admission, a student must have:

1. An all–university grade–point average of 2.50 or better.
2. A grade–point average of 3.00 or better in the following courses: Interior Design 140, 142, 150, 152, 240, 250, 252, and Apparel and Textile Design 231. 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 above and who have completed Interior Design 252. 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. In addition, factors such as diversity and residency may be considered.

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 340, 440, 442, and 452. Those courses are 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 in the School of Planning, Design and Construction:		62
	ATD 231	Textile Materials	4
	IDES 140	Design for Living	3
	IDES 142	Design Theory Studio	3
	IDES 150	Interior Design Drafting	3
	IDES 152	Interior Environments	4
	IDES 240	Computer–Aided Design for Designers	3
	IDES 250	CAD and Structural Systems	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	3
	IDES 451	Interior Design Professional Practice	2
	IDES 452	Interior Design Synthesis III	4
b.	The following course:		3
	CSE 101	Computing Concepts and Competencies	3
	Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101. An approved computer skills course may be substituted for CSE 101.		
c.	The following course:		5
	MTH 116	College Algebra and Trigonometry	5
d.	One of the following courses:		3
	EC 201	Introduction to Microeconomics	3
	EC 202	Introduction to Macroeconomics	3
e.	Any **one** of the following History of Art options (6 to 9 credits):		
	(1)	Any two History of Art courses (6 to 9 credits).	
	(2)	Any one History of Art course (3 or 4 credits), and Study Abroad through enrollment in IDES 490 Independent Study (3 to 5 credits).	
	(3)	Any one History of Art course (3 to 4 credits) and IDES 456 Historic Preservation and Sustainability (3 credits)	

LANDSCAPE ARCHITECTURE

The undergraduate Bachelor of Landscape Architecture program provides a diverse learning experience which strives for a balance among philosophy, theory, and application of concepts related to past, present, and future problem–solving in landscape architecture and allied environmental planning and design professions.

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 design opportunities and challenges within the classroom and on community projects, which prepare the student to communicate through writing, speech and graphics. These objectives are met in group and in individual assignments where independent study and growth are encouraged.

The program in landscape architecture 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 as a Junior

The number of students who can be admitted as juniors to the landscape architecture major is limited. To be considered for admission as a junior, a student must have completed the core courses referenced in item 2. below. Students who have been admitted as juniors are entitled to enroll in upper-level landscape architecture courses required for the Bachelor of Landscape Architecture degree.

To be admitted to the Bachelor of Landscape Architecture 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; and (4) a written essay.

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.

Detailed information regarding admission requirements and procedures is available from the School of Planning, Design and Construction, Associate Director.

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 and 106, and Chemistry 141 and 161. The completion of Plant Biology 106 and Chemistry 161 satisfies the laboratory requirement. Plant Biology 105 and 106, and Chemistry 141 and 161 may be counted toward both the alternative track and the requirements for the major referenced in item 2. below.

   The completion of Mathematics 116 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–point average of 2.00 in the 42 credits required in 300–400 level Landscape Architecture courses referenced in requirement 2.c. below.		
b.	Collateral Courses:		36
	(1)	All of the following courses (33 credits):	
	CEM 141	General Chemistry	4
	CEM 161	Chemistry Laboratory I	1
	HRT 211	Landscape Plants I[1]	3
	HRT 212	Landscape Plants II[1]	3
	HRT 311	Landscape Design and Management Specifications	4
	ISS 310	People and the Environment (I)[1]	4
	MTH 116	College Algebra and Trigonometry[1]	5
	PDC 120	Planning and Design Digital Graphics[1]	2
	PLB 105	Plant Biology[1]	3
	PLB 106	Plant Biology Laboratory[1]	1
	UP 424	Geographic Information Systems and Design Tools for Planning	3
	(2)	Students must demonstrate AutoCAD proficiency through transfer credit, waiver or completion of the following course (0 to 3 credits)[1]:	
	IDES 240	Computer-Aided Design for Designers	3
c.	Landscape Architecture Courses: All of the following courses:		61
	LA 140	Graphics and Two-Dimensional Design Studio[1]	4
	LA 141	Graphics and Three-Dimensional Design Studio[1]	4
	LA 200	Introduction to Landscape Architecture[1]	3
	LA 230	Site Construction Materials and Methods[1]	4
	LA 231	Landscape Site Engineering[1]	4
	LA 242	Creating Space Studio[1]	4
	LA 243	Place Making Studio[1]	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 (W)	3
d.	One of the following courses:		3

EC 201 Introduction to Microeconomics 3
EC 202 Introduction to Macroeconomics 3

e. Directed Electives: 14
A minimum of 14 additional credits in courses approved by the student's academic advisor. 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. (2) above may not be used to satisfy this requirement.

[1] Core course that must be completed in order for a student to be considered for admission to the major.

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.

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:

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 have not completed the credits referenced in item 4. above may be admitted on provisional status. In addition, students may be required to complete specified collateral courses, from the following list, 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.

One of the following courses:
CMP 124 Residential Construction Materials and Methods
CMP 210 Commercial Construction Methods
One of the following courses:
CMP 305 Site Construction and Measurements
CMP 315 Construction Quantity Surveying
One or more of the following courses:
CMP 222 Statics and Strengths of Materials
CMP 322 Structural Systems
CSE 101 Computing Concepts and Competencies
Business, management or economics course

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:

Requirements for Plan A

			CREDITS
1. A minimum of 18 credits in 800–900 level courses.			
2. All of the following courses:			
CMP	817	Construction Management Information Systems	3
CMP	822	Legal Issues in Construction	3
CMP	892	Construction Management Research Seminar	2
3. One additional 800-level Construction Management courses, excluding Construction Management 890, 898, and 899. Students without a background in construction project scheduling and estimating must complete Construction Management 811 and 815 in partial fulfillment of this requirement.			
4. One graduate course in research methods.			
5. 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 Management Information Systems	3
CMP	822	Legal Issues in Construction	3
CMP	892	Construction Management Research Seminar	2
3. One additional 800-level Construction Management course, excluding Construction Management 890, 898, and 899. Students without a background in construction project scheduling and estimating must complete Construction Management 811 and 815 in partial fulfillment of this requirement.			
4. One 400-level course or above in statistics.			

Additional Requirements for Plan B

1. Successful completion of a final examination given by 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 prospective or practicing professionals to address the complex interdisciplinary nature of environmental design. Students will develop a highly individualized plan of study with a focus in a relevant design area such as golf course architecture, landscape reclamation, visual quality modeling, landscape restoration, interiorscapes, wellness/therapeutic garden design, landscape development systems, plant management systems, adaptive reuse of facilities for tourism and recreation, park safety design and development, and park and tourism development and design within ecological systems.

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 design; and
4. a greater command of 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.			24
5. Complete and successfully defend a dissertation in an area related to area of concentration.			

DEPARTMENT of PLANT, SOIL and MICROBIAL SCIENCES

James J. Kells, 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 na-

tionally 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 international agriculture, sustainable agriculture and food systems, and in agronomy.

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. Students enrolled in this degree program, based on the agreement of cooperation between Michigan State University and Beijing Forestry University, Northeast Agricultural University, Sichuan Agricultural University, and Suzhou Polytechnic Institute of Agriculture in China must complete the concentration in Turfgrass Management.

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 on any of the specializations, refer to the *General Index* section in this publication or visit *http://www.reg.msu.edu/UCC/specializations.asp.*

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 488 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 382 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 488 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:			7
	CEM	161	Chemistry Laboratory I	1
	CSS	110	Computer Applications in Agronomy	2
	CSS	210	Fundamentals of Soil Science	3
	CSS	492	Professional Development Seminar II	1
b.	One of the following three concentrations:			61 to 72
	Agronomic Sciences (61 or 62 credits):			
	(1) All of the following courses (53 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	288	Principles of Weed Management	3
	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	3
	MTH	116	College Algebra and Trigonometry	5
	PLB	105	Plant Biology	3
	PLB	106	Plant Biology Laboratory	1
	PLP	405	Plant Pathology	3
	(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

Turfgrass Management (67credits):

(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 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 292 Management of Turfgrass Weeds . . . 3
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 364 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 (72 credits):

(1) All of the following courses (68 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 288 Principles of Weed Management . . . 3
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 . . . 3
MTH 132 Calculus I . . . 3
PLB 105 Plant Biology . . . 3
PLB 106 Plant Biology Laboratory . . . 1
PLP 405 Plant Pathology . . . 3

(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 16 to 19 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. One of the following courses (2 or 3 credits):
CSS 222 New Horizons in Biotechnology . . . 2
CSS 350 Introduction to Plant Genetics . . . 3
CSS 441 Plant Breeding and Biotechnology . . . 3
3. One of the following courses (2 or 3 credits):
CSS 135 Crop Scouting and Investigation . . . 2
CSS 151 Seed and Grain Quality . . . 2
CSS 201 Forage Crops . . . 3
CSS 212 Advanced Crop Production . . . 2
CSS 251 Organic Farming Principles and Practices . . . 3
CSS 288 Principles of Weed Management . . . 3
CSS 424 Sustainable Agriculture and Food Systems: Integration and Synthesis . . . 3
CSS 431 International Agricultural Systems . . . 3
CSS 467 Bioenergy Feedstock Production . . . 3
4. One of the following courses (2 or 3 credits):
CSS 330 Soil Chemistry . . . 2
CSS 340 Applied Soil Physics . . . 2
CSS 360 Soil Biology . . . 3
CSS 470 Soil Resources . . . 3

MINOR IN INTERNATIONAL AGRICULTURE

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 international agriculture. 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 specialization will be prepared for effective employment in the arena of international agriculture and/or multinational firms.

The College of Agriculture and Natural Resources in cooperation with the Departments of Agricultural, Food, and Resource Economics, Animal Science, Food Science and Human Nutrition, Plant, Soil and Microbial Sciences, and Forestry, and the College of Social Science in cooperation with the Department of Geography participate in the Minor in International Agriculture. The Department of Plant, Soil and Microbial Sciences is the primary administrative unit.

The student's program of study for the specialization must be approved by the Department of Plant, Soil and Microbial Sciences in advance and in writing. With the approval of the department that administer's 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 International Agriculture

The student must meet the requirements specified below:

CREDITS

1. **Foreign Language** . . . 0 to 8
Complete the equivalent of one year of a foreign language. The requirement may be met by completing two semesters of a foreign language at MSU or by obtaining a sufficient score on the appropriate foreign language placement test to place into a 200-level course in that language.

2.	**Study Abroad Experience**			6 to 12
	Complete at least one study abroad experience that has a minimum duration of five weeks or two experiences of shorter duration.			
3.	Both of the following courses:			4
	CSS	294	Issues in International Agriculture	1
	CSS	431	International Agricultural Systems	3
4.	One of the following courses:			3
	ABM	427	Global Agri-Food Industries and Markets	3
	ANR	250	Global Issues in Agriculture and Natural Resources	3
	ANS	480	Animal Systems in International Development	3
	EEP	260	World Food, Population and Poverty	3
	GEO	410	Geography of Food and Agriculture	3
	HNF	406	Global Foods and Culture	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

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, plant breeding, genetics and biotechnology—crop and soil sciences, and in plant pathology. The department also offers a Doctor of Philosophy degree program in crop and soil sciences—environmental toxicology.

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.

Students who are enrolled in Master of Science degree programs in the Department of Plant, Soil and Microbial Sciences may elect a Specialization in Food Safety. For additional information, refer to the statement on the specialization in the *College of Veterinary Medicine* section of this catalog.

CROP AND SOIL SCIENCES

The department offers the following areas of specialization within the field of crop and soil sciences: 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

Applicants for admission to the master's degree program should have a bachelor's degree in crop and soil sciences or in a related field such as botany or chemistry. Applicants should also have substantial academic background in the physical sciences (including chemistry and physics), in the biological sciences (including botany), and in mathematics. The completion of an undergraduate crop and soil sciences major with an agricultural science specialization would be considered ideal. 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.

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. In addition to courses in the major, a minor or study in areas related to crop and soil sciences is required. Students are encouraged to select such courses as botany, biochemistry, chemistry, geology, plant pathology, and statistics. The student is required to complete satisfactorily one semester of teaching.

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 Crop and Soil Sciences

In addition to courses in the major, a minor or study in areas related to crop and soil sciences is required. Students are encouraged to select such courses as botany, biochemistry, chemistry, geology, plant pathology, and statistics. The student is required to complete satisfactorily one semester of teaching.

CROP AND SOIL SCIENCES—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in crop and soil sciences—environmental toxicology, refer to the statement on *Doctoral Program in Environmental and Integrative Toxicological Sciences* in the *Graduate Education* section of this catalog.

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

Master of Science

Plant pathology graduate students may study in one or more emphasis areas, including phytobacteriology, 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 urged to take courses which provide a broad background in biological and physical sciences in addition to training in specialized areas.

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.

Requirements for the Master of Science Degree in Plant Pathology

The master's degree program in plant pathology is available under either Plan A (with thesis) or Plan B (without thesis). The student's program of study is arranged by a guidance committee which includes the major professor.

For both Plan A and Plan B, students must:

1. Complete at least 30 credits including at least two graduate-level seminar courses in the biological sciences, one of which must be Plant Pathology 894.
2. Acquire teaching experience by assisting in at least one course.
3. Demonstrate a reading knowledge of a foreign language if required by the guidance committee.

Additional Requirement for Plan A:

Pass a final oral examination in defense of the thesis.

Additional Requirement for Plan B:

Pass a final examination or evaluation.

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 teaching experience by assisting in two courses.
3. Complete:

				CREDITS
a.	All of the following courses:			
	PLP	405	Introductory Plant Pathology	3
	PLP	810	Current Concepts in Plant Pathology	3
	PLP	894	Seminar in Plant Pathology	2
b.	One of the following courses:			
	PLP	812	Epidemiology of Plant Diseases	3
	PLP	881	Molecular and Biochemical Plant Pathology	3
	PLP	885	Plant Diseases in the Field	2
c.	Two of the following courses:			
	ENT	870	Nematode Management in Crop Systems	3
	PLP	847	Advanced Mycology	4
	PLP	880	Plant Virology	4
	PLP	884	Prokaryotic Diseases of Plants	4

4. Additional requirements such as reading knowledge of a foreign language may be required by the guidance committee.
5. Pass a written comprehensive examination.
6. Pass a final oral examination in defense of a dissertation.

GRADUATE SPECIALIZATION IN ECOLOGICAL FOOD AND FARMING SYSTEMS

The Graduate Specialization in Ecological Food and Farming 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 students 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 Ecological Food and Farming Systems

				CREDITS
The student must complete 13 to 14 credits from the following:				
1.	All of the following courses (7 credits):			
	ACR	811	Community, Food and Agriculture: A Survey	3
	CSS	442	Agricultural Ecology	3
	CSS	892B	Ecological Food and Farming Systems 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	893	Special Topics	3
	ENT	479	Organic Pest Management	3
	ENT	848	Biological Control of Insects and Weeds	3
	An international course approved by the student's advisor for the specialization.			
3.	One of the following courses (3 or 4 credits):			
	ACR	823	Contemporary Issues in Animal-Human Relationships	3
	ACR	853	The Industrialization of American Agriculture	3
	ACR	854	Agriculture and Social Movements	3
	ACR	891B	Advanced Topics in Community, Food, and Agriculture	2
	AEC	861	Agriculture in Economic Development	3
	FW	858	Gender, Justice, and Environmental Change: Issues and Concepts	3
	GEO	410	Geography of Food and Agriculture	3
	An international course approved by the student's advisor for the specialization.			

Students may enroll in Community, Agriculture, Recreation and Resource Studies 891B more than once.

DEPARTMENT of PLANT BIOLOGY

Richard E. Triemer, 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

Founded in 1894, the Institute of Agricultural Technology delivers innovative, educational programs on campus and with community college partners that develop career-ready graduates through intensive, practical learning and skill enhancement in agricultural, environmental, and applied technologies. The Institute seeks to prepare students for dynamic careers in a changing world. Programs are designed to be assessable, affordable and applied. Graduates have the knowledge and skill base to meet the needs of the industry. Certificate programs vary from 18 to 24 months in length. Programs are highly respected statewide, nationally, and international. Courses are taught by faculty and staff in the College of Agriculture and Natural Resources, so students gain from the research and extension programs at Michigan State University. For additional information on any of the certificate programs, write to the Institute of Agricultural Technology, Michigan State University, Agriculture Hall, 446 W. Circle Drive, Room 121, East Lansing, MI 48824-1039.

PROGRAMS

Agricultural Industries

The Agricultural Industries program is designed to provide students in gaining in-depth agricultural industry and business knowledge to apply to their own operation or to launch a career in the industry. Students have the flexibility to focus on agronomy, horticulture, animal science or agricultural business through integration of hands-on laboratory learning and classroom formats. Students who are interested may be eligible to transfer into a four-year degree program at MSU upon completion of the certificate.

Requirements for Agricultural Industries

				CREDITS
The student must complete 48 credits from the following:				
1.	All of the following courses (31 to 34 credits):			
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	130	Farm Management I	3
	AT	045	Agricultural Communications	2
	AT	055	Agricultural Finance	3
	AT	071	Technical Mathematics	2
	AT	214	Leadership Development in Agriculture and Natural Resources Industries	2
	AT	293	Professional Internship in Agricultural Technology	3 to 6
	CSS	101	Introduction to Crop Science	3
	CSS	101L	Introduction to Crop Science Laboratory	1
	CSS	105	Agricultural Industries Seminar	1
	CSS	110	Computer Applications in Agronomy	2
	CSS	120	Issues in Food and Agriculture	3
	CSS	288	Principles of Weed Management	3
2.	One of the following courses (3 credits):			
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ABM	225	Commodity Marketing I	3
3.	One of the following courses (2 or 3 credits):			
	CSS	143	Introduction Soil Science	2
	CSS	210	Fundamentals of Soil Science	3
4.	Complete a minimum of 13 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.

Students who do not demonstrate math proficiency through the IAT-administered Accuplacer placement test or college-level transfer credit must complete AT 071 Technical Mathematics (2 credits) as approved by the program coordinator.

Agricultural Operations

The Agricultural Operations program provides students with a solid background in plant and soil science, precision agriculture, water management, entomology, plant pathology and business management. It exposes students to exciting opportunities available in the industry.

Requirements for Agricultural Operations

Students must complete 55 credits from the following: — CREDITS

1. All of the following courses (29 credits):
   - ABM 130 Farm Management I . . . 3
   - AE 131 Agricultural Water Resource Management . . . 3
   - AE 143 Application of Precision Agriculture Technologies . . . 3
   - AT 202 Agricultural Regulation, Compliance and Safety . . . 3
   - AT 293 Professional Internship in Agricultural Technology . . . 3
   - CSS 101 Introduction to Crop Science . . . 3
   - CSS 105 Agricultural Industries Seminar . . . 1
   - CSS 135 Crop Scouting and Investigation . . . 3
   - CSS 143 Introduction to Soil Science . . . 2
   - ENT 110 Applied Entomology of Economic Plants . . . 3
   - PLP 105 Fundamentals of Applied Plant Pathology . . . 2
2. Completion of a minimum of 5 additional elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.
3. Completion of 21 credits of additional course work through Delta College, Glen Oaks Community College, Kellogg Community College, Monroe Community College, Montcalm Community College, Muskegon Community College, Northwestern Michigan College, Southwestern Michigan College, or West Shore Community College. All course work must be approved by the program coordinator in the Institute of Agricultural Technology.

Applied Horse Science

The Applied Horse Science certificate, in partnership with Montcalm Community College, provides students the opportunity to study an in-depth horse science curriculum outside of the traditional classroom and provides learning experiences that improve the profitability, animal welfare, environmental stewardship and recreation by horse enthusiasts.

Requirements for Applied Horse Science

CREDITS

1. All of the following courses (14 credits):
   - ANS 140 Fundamentals of Horsemanship . . . 2
   - ANS 149 Horse Management Clerkship . . . 2
   - ANS 200D Introductory Judging of Horses . . . 2
   - ANS 225 Horse Behavior and Welfare . . . 2
   - ANS 243 Horse Nutrition and Feeding . . . 2
   - ANS 244 Horse Facility Design and Management . . . 2
   - ANS 247 Horse Health . . . 2
2. One of the following courses (2 credits):
   - ANS 140 Fundamentals of Horsemanship . . . 2
   - ANS 148 Methods of Safe Horsemanship . . . 2
3. Two credits from the following courses (2 credits):
   - ANS 143 Principles of Trail Riding . . . 1
   - ANS 144 Introduction to Horse Breeding and Foal Management . 1
   - ANS 148 Methods of Safe Horsemanship . . . 2
   - ANS 248 Horse Reproductive Technology and Breeding Techniques 2

   Students may not use ANS 148 to fulfill both requirement 2. and 3.
4. Complete 17 credits of course work from Montcalm Community College as approved by the student's academic advisor.

Applied Plant Science

Employment and career opportunities continue to expand for those who have training and educational preparation in applied plant science. In response to this regional plant industry need, Northwestern Michigan College (NMC) partners with Michigan State University to offer a combined program, which enables students to complete an Associate of Applied Science degree through Northwestern Michigan College as well as an MSU Institute of Agricultural Technology certificate - without leaving their local area.

Bringing together the world-acclaimed expertise of Michigan State University's College of Agriculture and Natural Resources and the "close to home" convenience of outstanding community colleges, the Applied Plant Science program prepares graduates for a wide range of employment and career choices. Each student receives personal, one-on-one help in selecting her/his program of study (including workplace internship). Students may earn their certificate in Applied Plant Science with concentrations in Commercial Horticulture Operations, Commercial Turfgrass Operations, or Landscape Horticulture.

Requirements for Applied Plant Science

1. All of the following courses (21 credits):
   - AT 293 Professional Internship in Agricultural Technology . . . 3
   - CSS 210 Fundamentals of Soil Science . . . 3
   - ENT 111 Basics of Applied Entomology . . . 3
   - ESA 225 Land and Environmental Issues in Law and Policy . . . 3
   - HRT 213 Landscape Maintenance . . . 2
   - HRT 215 Landscape Industries Seminar . . . 1
   - HRT 218 Landscape Irrigation . . . 3
   - PLP 200 Plant Diseases and Pathogens . . . 3
2. One of the following concentrations (9 credits):

   Commercial Horticulture Operations

   Complete 9 credits from the following:
   - HRT 205 Plant Mineral Nutrition . . . 1
   - HRT 208 Pruning and Training Systems in Horticulture . . . 3
   - HRT 221 Greenhouse Structures and Management . . . 3
   - HRT 242 Passive Solar Greenhouses for Protected Cultivation . . 1
   - HRT 251 Organic Farming Principles and Practices . . . 3
   - HRT 253 Compost Production and Use . . . 1
   - HRT 332 Tree Fruit Production and Management . . . 2
   - HRT 335 Berry Crop Production and Management . . . 1
   - HRT 341 Vegetable Production and Management . . . 3

   Commercial Turfgrass Operations

   1. All of the following courses:
      - CSS 202 The World of Turf . . . 2
      - CSS 203 Applied Turf Management . . . 1
      - CSS 290 Independent Study in Crop and Soil Science . . . 1
      - CSS 292 Management of Turfgrass Weeds . . . 3
   2. Complete a minimum of 2 credits from the following:
      - CSS 181 Pesticide and Fertilizer Application Technology . . 3
      - HRT 111 Landscape Design . . . 3
      - HRT 208 Pruning and Training Systems in Horticulture . . . 3
      - HRT 211 Landscape Plants I . . . 3
      - HRT 212 Landscape Plants II . . . 3
      - HRT 214 Landscape and Turfgrass Business Operations . . 2
      - HRT 290 Independent Study in Horticulture . . . 2

   Landscape Horticulture

   All of the following courses:
   - HRT 111 Landscape Design . . . 3
   - HRT 211 Landscape Plants I . . . 3
   - HRT 212 Landscape Plants II . . . 3
3. Complete 22 credits of course work from Northwestern Michigan College as approved by the student's academic advisor.

Beef Cattle Management

This program allows specialization in the area of beef cattle management in a one-year intensified program. It provides knowledge and experience in the management of both cow/calf and feedlot enterprises. There is a demand for industrious young people with practical experience to fill positions of responsibility as herd managers, assistant herd managers, and other livestock-related jobs.

Agriculture, in this rapidly changing era, requires aggressive young people who have specialized training in modern scientific practices. While the demands for success are great, the opportunities for success are limited only by a person's desires or imagination.

Requirements for Beef Cattle Management

The student must complete 35 credits from the following: — CREDITS

1. All of the following courses:
   - ANS 110 Introductory Animal Agriculture . . . 4
   - ANS 122A Feedlot Clerkship . . . 2
   - ANS 122B Beef Cow Calf Clerkship . . . 2
   - ANS 203 Principles of Livestock Feeding . . . 2
   - ANS 205 Reproduction in Livestock . . . 2
   - ANS 222 Introductory Beef Cattle Management . . . 3

	AT	045	Agricultural Communications	2
	AT	071	Technical Mathematics	2
	AT	293	Professional Internship in Agricultural Technology	6
2.	Both of the following courses:			
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	130	Farm Management I	3
3.	Complete 7 credits of elective course work			7

Dairy Management

Because dairy farming is among the leading agricultural enterprises in Michigan, the dairy program has been developed to meet the specialized needs of the herd manager and commercial dairy farmer. Opportunities abound for persons with the combination of classroom training in the areas of dairy husbandry, nutrition, artificial insemination, crops, and farm management and the practical experience that may be obtained on any of the many cooperating dairy farms in Michigan and the surrounding states.

Programs of study tailored to meet the individual's wants and needs are designed around the subject matter areas of agricultural economics, communications, crop and soil sciences, and agricultural mechanics. Additionally, students learn about the continuing changes in rural living, which have a great influence on agriculture.

Requirements for Dairy Management

CREDITS

The student must complete 48 credits from the following:

1.	All of the following courses (32 credits):			
	ANS	132	Dairy Farm Management Seminar	1
	ANS	203	Principles of Livestock Feeding	2
	ANS	215	Growth, Health and Lactation in Dairy Cattle	2
	ANS	230	Dairy Herd Management	3
	ANS	232	Introductory Dairy Cattle Management	3
	ANS	233	Dairy Feed Management	3
	ANS	235	Dairy Herd Reproduction	2
	ANS	238	Dairy 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 16 credits of course work in the college from the following as approved by the program coordinator in the Institute of Agricultural Technology:			
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	130	Farm Management I	3
	ABM	225	Commodity Marketing I	3
	ANS	110	Introductory Animal Agriculture	4
	ANS	222	Introductory Beef Cattle Management	3
	AT	055	Agricultural Finance	3
	CSS	101	Introduction to Crop Science	3
	CSS	120	Issues in Food and Agriculture	3
	CSS	201	Forage Crops	3
	CSS	212	Advanced Crop Production	2

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.

Students who do not demonstrate math proficiency through the IAT-administered Accuplacer placement test or college-level transfer credit must complete AT 071 Technical Mathematics (2 credits) as approved by the program coordinator.

Electrical Technology

The Electrical Technology certificate is an electrical apprenticeship training program with an emphasis on residential, agricultural, commercial, and industrial wiring. Students study electrical codes, fundamentals, installations, motor controls, and solid state electronic applications. Throughout the program, students receive training in energy efficiency and alternate power systems. The certificate provides advanced technical training important for a successful career in the electrical field.

Integrated in the 15-month program are a wide range of disciplines through hands-on classroom and laboratory learning, and on-the-job training. The 4,000 square feet laboratory is equipped with electrical systems found in agricultural, commercial, and industrial facilities as well as systems that serve residential homes. The laboratory also has programmable logic controls, variable frequency drives, and standard AC and DC motors used in the field. The skills learned are used to become a licensed journey electrician through the State of Michigan, which is recognized by the State Electrical Administrative Board. Students who are interested may transfer into a four-year degree program at MSU upon completion of the certificate.

Requirements for Electrical Technology

CREDITS

1.	All of the following courses (37 to 40 credits):			
	AE	172	Electrical Wiring I	4
	AE	173	Electrical Occupations	1
	AE	182	Electrical Wiring II	2
	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
	CSS	110	Computer Applications in Agronomy	2
	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 will take elective course work to substitute the credit in those courses.			
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 5 to 15 credits of additional Agricultural Technology courses chosen in consultation with and approved by the program coordinator.			

Fruit and Vegetable Crop Management

The Fruit and Vegetable Crop Management program provides students an opportunity to apply practical knowledge and training on the selection, use, and management of fruit and vegetable crops. The program combines classroom instruction and theory with practical experience gained through field laboratories and a professional internship. Graduates of the program are prepared for careers in the fruit and vegetable industry.

Requirements for Fruit and Vegetable Crop Management

CREDITS

Students must complete 48 credits from the following:

1.	All of the following courses (18 credits):			
	AT	202	Agricultural Regulation Compliance and Safety	3
	AT	293	Professional Internship in Agricultural Technology	3
	CSS	143	Introduction to Soil Science	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	3
	PLP	105	Fundamentals of Applied Plant Pathology	2
2.	Completion of 9 additional elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.			
3.	Completion of 21 credits of additional course work through Delta College, Kellogg Community College, Monroe Community College, Montcalm Community College, Muskegon Community College, Northwestern Michigan College, Southwestern Michigan College, Wayne County Community College, or West Shore Community College. 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 an opportunity to gain the necessary skills for a successful career in the multibillion dollar fruit and vegetable industries. The program combines classroom instruction and theory with practical experience gained through field laboratories and a professional internship. Graduates of the program work as owners, managers, buyers, or salespersons in a wide va-

riety of horticultural food crop industries: fruit and vegetable plan production; farmers' markets; organic farms and community-supported agriculture programs; urban gardening; irrigation design, installation, and management; public and/or private botanical gardens; and more.

Horticulture is a complex and diversified, yet fully integrated discipline that encompasses the biological, molecular, physical, management and marketing sciences and the arts to improve the production of nutritious, high-quality and safe food, advance the development and use of new specialty crops, enhance human health and well-being, and positively impact the natural and built environments.

Students may enroll in online courses, courses that are integrated with outreach and extension programs, and 5- or 10- week courses. They will have opportunities to be extensively involved in professional and social activities beyond the classroom including: working in research laboratories; assisting in field-based projects, assisting with food crop production; and becoming involved with the Student Organic Farm, and the Ecological Food and Farm Stewardship Club.

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	045	Agricultural Communications	2
AT	071	Technical Mathematics	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	206	Training and Pruning Plants	1
HRT	207	Horticulture Career Development	1
HRT	218	Irrigation Systems for Horticulture	3
PLP	105	Fundamentals of Applied Plant Pathology	2

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.

Students who do not demonstrate math proficiency through the IAT-administered Accuplacer 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.

2. A minimum of 15 credits from the following courses:

ABM	100	Decision-making in the Agri-Food System	3
ABM	222	Agribusiness and Food Industry Sales (W)	3
AT	055	Agricultural Finance	3
AT	101	Spanish for the Agricultural Industry	2
HRT	203	Principles of Horticulture	3
HRT	204	Plant Propagation	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

3. Completion of 10 additional elective credits in the college as approved by program coordinator in the Institute of Agricultural Technology.

Grounds Management

The Grounds Management certificate is delivered in partnership between Wayne County Community College District and the Michigan State University Institute of Agricultural Technology. It is designed for persons interested in careers managing commercial, private, school, or community athletic facilities and landscapes.

Graduates of the program will receive a certificate from the Michigan State University Institute of Agricultural Technology and will have the opportunity to complete a test to become a certified pesticide applicator with the Michigan Department of Agriculture. Additional course work may lead to a Certificate in Grounds Management from Michigan State University and a Certificate in Facilities Maintenance from Wayne County Community College District, making the graduate more qualified to manage both indoor and outdoor facilities. Students may continue their course work to obtain an Associate in Applied Science Degree from Wayne County Community College District in addition to the certificate from Michigan State University.

Requirements for Grounds Management

The student must complete 50 credits from the following:

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

AT	291	Special Topics in Agricultural Technology	1
AT	293	Professional Internship in Agricultural Technology	3
CSS	202	The World of Turf	2
CSS	203	Applied Turf Management	1
CSS	210	Fundamentals of Soil Science	3
CSS	269	Turfgrass Strategies: Integration and Synthesis	2
CSS	292	Management of Turfgrass Weeds	3
ENT	111	Basics of Applied Entomology	2
HRT	214	Landscape and Turfgrass Business Operations	2
HRT	218	Landscape Irrigation	3
PLP	104	Applied Plant Pathology for Ornamentals and Turf	3

2. Complete 25 credits of course work from Wayne County Community College District as approved by the student's academic advisor.

Horse Management

The horse management program places emphasis on acquisition of equine husbandry skills that will prepare students for jobs in the ever-growing horse industry or for the management of their own farms and horses. Students are required to complete a one-semester placement training experience working with professionals in the horse industry. Study abroad opportunities may also be incorporated into the student's program. The horse industry has exciting job opportunities for students who have a passion for horses and a strong work ethic. Students who complete this program will be prepared for positions ranging from assistant trainers to managers of small farms and from racetrack grooms to tack and equipment sales personnel.

Requirements for Horse Management

The student must complete 48 credits from the following:

1. All of the following courses (37 to 40 credits):

			CREDITS
ABM	130	Farm Management I	3
ANS	140	Fundamentals of Horsemanship	2
ANS	145	Horse Behavior and Welfare	1
ANS	146	Fundamentals of Horse Training	3
ANS	147	Horse Management Placement Seminar	1
ANS	149	Horse Management Clerkship	2
ANS	200D	Introductory Judging of Horses	2
ANS	203	Principles of Livestock Feeding	2
ANS	205	Reproduction in Livestock	2
ANS	240	Horse Farm Management	3
ANS	242	Introductory Horse Management	3
ANS	243	Horse Nutrition and Feeding	2
ANS	245	Horse Exercise Physiology	2
AT	045	Agricultural Communications	2
AT	071	Technical Mathematics	2
AT	293	Professional Internship in Agricultural Technology	6
CSS	110	Computer Applications in Agronomy	2

2. Complete 8 to 11 credits of elective course work from the following:

ANS	110	Introductory Animal Agriculture	4
ANS	141	Draft Horse Basics	2
ANS	142	Horse Training for Competition	2
ANS	148	Methods of Instructing Safe Horsemanship	2
ANS	290	Independent Study in Agricultural Technology	2 to 6
ANS	300D	Advanced Horse Judging	2
AT	291	Selected Topics in Agricultural Technology	2
CSS	201	Forage Crops	3
KIN	125	First Aid and Personal Safety	3
Study abroad			6

Landscape and Nursery Management

The Landscape and Nursery Management program at Michigan State University provides students an opportunity to gain the necessary skills for a successful career in the multibillion dollar green industry. The program combines classroom instruction and theory with practical experience gained through field laboratories and a professional internship. Graduates of the program work as

owners, managers, buyers, or salespersons in a wide variety of horticultural industries: landscape design, construction, and management; irrigation design, installation, and management; retail garden center management; herbaceous and woody plant production; urban tree management; and public and/or private botanical gardens.

Horticulture is a complex and diversified, yet fully integrated discipline that encompasses the biological, molecular, physical, management and marketing sciences and the arts to improve the production of nutritious, high-quality and safe food, advances the development and use of new specialty crops, enhances human health and well-being, and positively impacts the natural and built environments.

Students will have opportunities to enroll in online courses, courses integrated with outreach and extension programs, and 5- or 10-week module courses. Students are extensively involved in activities beyond the classroom such as working in research laboratories; assisting in field-based projects, landscape, greenhouse, garden, and nursery operations; running the Horticulture Club's annual spring show and plant sale; and participating in academic and field events associated with the Professional Landcare Network (PLANET).

The Landscape and Nursery Management program is offered by the Department of Horticulture in cooperation with the Institute of Agricultural Technology.

Requirements for Landscape and Nursery Management

1. All of the following courses (30 credits): — CREDITS

AT	045	Agricultural Communications	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	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
PLP	105	Fundamentals of Applied Plant Pathology	2

2. Complete at least 9 credits from the following courses in the college as approved by the program coordinator in the Institute of Agricultural Technology:

AE	153	Engine and Equipment Technology	2
AT	101	Spanish for the Agricultural Industry	2
CSS	181	Pesticide and Fertilizer Application Technology	3
CSS	202	World of Turf	2
HRT	204	Plant Propagation	2
HRT	218	Irrigation Systems for Horticulture	3
HRT	219	Landscape Computer Aided Design	2
HRT	221	Greenhouse Structures and Management	3

3. Complete a minimum of 9 additional credits in the college chosen in consultation with and 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.

Landscape and Lawn Management

The Landscape and Lawn Management program is a unique partnership between the Michigan State University College of Agriculture and Natural Resources' Institute of Agricultural Technology and Grand Rapids Community College. This program provides students an opportunity to gain the necessary skills for a successful career in the billion-dollar landscape and nursery industry without leaving the Grand Rapids area. Graduates of the program work as owners, managers, buyers, or salespersons in retail firms, commercial landscape construction and maintenance operations, and as well as for private enterprises.

The program combines the theories and principles of classroom instruction with the practical experience of placement training. Although the emphasis is on landscape and lawn management, other important aspects of a college education are included. Students are required to take courses in fields such as written communications, botany, business management, computer science, soil science, plant pathology, entomology, ornamental plant identification, and much more.

Upon completion of the program requirements for the certificate, students also have the option of completing 20 additional credits at Grand Rapids Community College to obtain an Associate of Applied Arts and Sciences degree. The additional courses are in business, chemistry, written communications, humanities, and social science.

Requirements for Landscape and Lawn Management

1. All of the following courses (25 credits): — CREDITS

AT	293	Professional Internship in Agricultural Technology	3
CSS	202	World of Turf	2
CSS	202L	World of Turf Lab	1
CSS	210	Fundamentals of Soil Science	3
ENT	110	Applied Entomology of Economic Plants	3
HRT	211	Landscape Plants I	3
HRT	212	Landscape Plants II	3
HRT	213	Landscape Maintenance	2
HRT	214	Landscape and Turfgrass Business Operations	2
PLP	104	Applied Plant Pathology for Ornamentals and Turf	3

2. Complete a minimum of 3 credits of course work from the Institute of Agricultural Technology as approved by the program coordinator.
3. Complete 20 credits of course work from Grand Rapids Community College as approved by the program coordinator.

Landscape Management

The Landscape Management program provides training for students to select, use, and manage landscape plants and lawns. Students obtain a working knowledge of plant growth, development, and identification which prepares them for careers in the green industry.

Requirements for Landscape Management

Students must complete 48 credits from the following: — CREDITS

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

AT	202	Agricultural Regulation, Compliance and Safety	3
AT	293	Professional Internship in Agricultural Technology	3
CSS	143	Introduction to Soil Science	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	3
PLP	105	Fundamentals of Applied Plant Pathology	2

2. Completion of 2 additional elective credits in the college as approved by the program coordinator in the Institute of Agricultural Technology.
3. Completion of 21 credits of additional course work through Kellogg Community College, Monroe Community College, Montcalm Community College, Muskegon Community College, Northwestern Michigan College, Southwestern Michigan College, Wayne Country Community College, or West Shore Community College. 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

CREDITS

1. All of the following courses (27 credits):
   - ABM 130 Farm Management I . . . 3
   - ANS 110 Introductory Animal Agriculture . . . 4
   - 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 222 Introductory Beef Cattle Management . . . 3
   - ANS 232 Introductory Dairy 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 a minimum of 12 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.

Students who do not demonstrate math proficiency through the IAT-administered Accuplacer placement test or college-level transfer credit must complete AT 071 Technical Mathematics (2 credits) as approved by the program coordinator.

Turfgrass Management

A rapidly expanding turfgrass industry offers many challenging job opportunities for trained personnel. The growing demand for recreational areas and rededication to the maintenance of beauty in America has created a shortage of turfgrass specialists.

Golf Course Emphasis

The golf course emphasis provides the fundamentals of turfgrass technology necessary primarily for the supervision and management of golf courses. Attractive starting salaries and many job opportunities are available with excellent potential for advancement. Previous work experience on a golf course maintenance crew is expected.

Requirements for the Golf Course Emphasis

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 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 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
   - CSS 288 Principles of Weed Management . . . 3
   - 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

The sports and commercial turf management emphasis is designed for persons interested in careers in these areas. These are rapidly growing areas of turfgrass management and offer rewarding job opportunities.

Requirements for the Sports and Commercial Turf Management Emphasis

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 to 6
   - CSS 110 Computer Applications in Agronomy . . . 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 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
   - CSS 288 Principles of Weed Management . . . 3
   - 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.

Swine Management

Food production, including that of pork, is increasing along with the world's population due to the use of scientific technologies and skilled people. If we are to keep pace with the growing population, we will need more of these two vital inputs. The tasks of developing new technologies and new human resources are equally challenging.

The swine management program is designed to prepare people for careers in modern pork production anywhere in the world. The one-year program judiciously balances "hands-on" training with classroom instruction in the areas of animal care, nutrition, housing maintenance, swine health, reproduction, records management, environmental management and personnel management. Students also gain practical experience through a summer-long internship on a commercial swine farm in Michigan or beyond. Swine management graduates will have numerous career opportunities including: farm owners/operators, managers or assistant managers (breeding herd, farrowing, nursery, grower-finisher, transportation, feeds, marketing), department supervisors or regional representatives.

Requirements for Swine Management

CREDITS

The student must complete 35 credits from the following:

1.	All of the following courses (32 credits):			
	ABM	130	Farm Management I	3
	AEE	110	Foundations of ANR Communications: Learning and Leadership	2
	ANS	110	Introductory Animal Agriculture	4
	ANS	171	Swine Clerkship	2
	ANS	203	Principles of Livestock Feeding	2
	ANS	205	Reproduction in Livestock	2
	ANS	272	Introductory Swine Management	3
	AT	045	Agricultural Communications	2
	AT	055	Agricultural Finance	3
	AT	071	Technical Mathematics	2
	AT	291	Selected Topics in Agricultural Technology	2
	AT	293	Professional Internship in Agricultural Technology	6
	CSS	110	Computer Applications in Agronomy	2
2.	Complete 3 credits of elective course work			3

Viticulture

The Viticulture certificate is delivered in partnership between Monroe Community College, Northwestern Michigan College, Southwestern Michigan College, the Viticulture and Enology Science and Technology Alliance (VESTA), and the Michigan State University Institute of Agricultural Technology. The combination of online viticulture courses delivered by experts from throughout the United States, hands-on experience at local vineyards, fresh markets, juice processors, packing plants and wineries and fundamental plant science courses provide graduates with the specific expertise and skills needed for careers in the rapidly expanding grape industry – supplying grapes for table, juice and wine making.

Graduates of the program will receive a certificate from the Michigan State University Institute of Agricultural Technology. Students may continue their course work to obtain an Associate in Applied Science Degree from the community college partners in addition to the certificate from Michigan State University. Should students wish to continue their education, the appropriate pre-designated credits may be applied to a bachelor's degree program at Michigan State University if students meet the established transfer guidelines.

Requirements for Viticulture

				CREDITS
1.	All of the following courses (21 credits):			
	AT	202	Agricultural Reglations, Compliance and Safety	3
	AT	293	Professional Internship in Agricultural Technology	3
	CSS	143	Introduction to Soil Science	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	2
2.	Complete 21 credits of additional course work through Monroe Community College, Northwestern Michigan College or Southwestern Michigan College as well as 6 credits through the Viticulture and Enology Science and Technology Alliance. All course work must be approved by the student's program coordinator.			

Admission

Applicants for technical programs must be high school graduates. A strong background in communications, mathematics, and science will help prepare the student for successful completion of a technical training program.

The admission process includes a consideration of the student's academic record, work experience, recommendations from employers, test scores, and other criteria. In some cases, students may be invited to Michigan State University for an interview.

Financial Aid

Institute of Agricultural Technology students are eligible for financial aid. Scholarships are provided by industry groups and individual business firms and are awarded to students who have demonstrated superior scholastic ability or an outstanding work record.

Veterans Education

The programs offered by the Institute of Agricultural Technology 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.

Institute of Agricultural Technology Transfer Student Admission

Institute of Agricultural Technology students who have completed their respective Institute of Agricultural Technology programs will, upon completion of the applications process, be considered for transfer admission to Michigan State University. Acceptance is determined by the applicant's previous academic record and his or her proposed program.

To complete the application process, the student must:

1. Complete and submit a signed request (*Student Intent to Transfer Form*) to the Institute of Agricultural Technology, as soon as the student develops an interest in transferring, in order to inform the Institute of Agricultural Technology of the desire to transfer to a baccalaureate program. The request must be signed by the program coordinator and by the Institute of Agricultural Technology Director in order to facilitate proper student advising by the Institute of Agricultural Technology.
2. Have a minimum grade point average of 3.0 upon completion of the Institute of Agricultural Technology program and satisfy all other requirements for admission.
3. Earn a minimum grade of 2.0 in WRA 110 or its equivalent.
4. Earn a minimum grade of 2.0 in MTH 103 or its equivalent.
5. Apply to the baccalaureate program using the application form from the Office of Admissions and Scholarships. It is recommended that students apply at the beginning of the semester they are to graduate from the Institute of Agricultural Technology.
6. Additional requirements may apply for limited enrollment programs.
7. Complete all other undergraduate application requirements.

For additional information regarding transfer admission, refer to the *Transfer Student Admission* statement in the *Undergraduate Education* section of this catalog.

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.

Based in the College of Agriculture and Natural Resources, AgBioResearch is composed of a network of on-campus laboratories and research centers across the state. More than 300 faculty members from 29 academic departments, research institutes and laboratories receive support from AgBioResearch. Beyond the college, 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 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 plots in East Lansing. Research also takes place at the 13 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 combines 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

Jeffrey Dwyer, Director

Michigan State University (MSU) Extension helps people improve their lives by bringing MSU's knowledge resources directly to individuals, 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.

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. Locally based Extension faculty and staff members provide tools to help people enhance their quality of life.

Extension programming is focused in four statewide programs: agriculture and agribusiness, health and nutrition, children and youth, and economic and community development.

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 reviews 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.

Economic and Community Development: Greening Michigan

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 FOOD-AG-BIO

Thomas Lyons, Director

The MSU Product Center Food-Ag-Bio was established in 2003, by the Michigan Agricultural Experiment Station (now AgBioResearch) and Michigan State University Extension, to im prove 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.

CENTER FOR GLOBAL CONNECTIONS IN FOOD, AGRICULTURE AND NATURAL RESOURCES

Gretchen Neisler, Director

The Center for Global Connections in Food, Agriculture and Natural Resources is administered jointly by the College of Agriculture and Natural Resources and International Studies and Programs. This Center is responsible for international activities in the fields of agriculture, natural resources, and related areas, both on campus and in other countries. Activities of the Center include the broad areas of international training, research, overseas institution building, and rural development abroad.

The Center for Global Connections in Food, Agriculture and Natural Resources is linked with the Colleges of Natural Science, and Veterinary Medicine. When appropriate, the Center interacts with additional colleges such as The Eli Broad College of Business, Education, Human Medicine, Osteopathic Medicine, and Veterinary Medicine.

Agricultural and natural resources faculty and students are active throughout the world, in both developed and developing countries. Many are concerned with research projects dealing with specific agricultural areas, while the remainder are technical advisors to higher agricultural education and research institutions in the developing countries.

More than 24 courses involving international agriculture and natural resources are available through interdisciplinary and departmental offerings.

INSTITUTE of WATER RESEARCH

Jon Bartholic, Director

The Michigan State University Institute of Water Research was established in 1961 to promote and coordinate water research, education, and advisory services for the inland waters and Great Lakes of Michigan. Serving as a boundary organization, the Institute is able to work across disciplinary boundaries and develop partnerships with campus departments, local and state agencies, and other Universities and organizations in the broad water arena. 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, including a professional certificate program 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.