College of AGRICULTURE and NATURAL RESOURCES

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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. 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, and international development.

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 Undergraduate University Division 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 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; Animal Science; Construction Management; Crop and Soil Sciences; Dietetics; Entomology; Environmental Economics and Policy; Environmental Soil Science; Environmental Studies and Agriscience; Fisheries and Wildlife; Food Industry Management; Food Science; Forestry; Horticulture; Packaging; Park, Recreation and Tourism Resources; Plant Pathology; and Technology Systems Management. 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.

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' training, 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) that will offer the best possible preparation for graduate study.

Freshmen

Students meeting the general requirements for admission shown in the *Undergraduate Education* section of this catalog are enrolled in the Undergraduate University Division. 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 Undergraduate University Division advisor and an advisor in their major.

Admission as a Junior to the College of Agriculture and Natural Resources

1. Completion of a minimum of 56 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.

The number of students admitted as juniors to the construction management major and the packaging major are limited. For additional information, refer to the statements on the *School of Planning, Design and Construction* and the *School of Packaging*.

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.

SPECIALIZATION IN AGRICULTURAL AND NATURAL RESOURCES BIOTECHNOLOGY

The Specialization in Agricultural and Natural Resources Biotechnology is available as an elective to students who are enrolled in Bachelor of Science degree programs with majors in animal science, biosystems engineering, crop and soil sciences, fisheries and wildlife, food science, forestry, and horticulture. The specialization is administered by the College of Agriculture and Natural Resources.

The specialization 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 specialization 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 specialization may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Specialization in Agricultural and Natural Resources Biotechnology

The student must complete:

				CREDITS
1.	All of the following courses (7 credits):			
	BMB	401	Basic Biochemistry	4
	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
	ZOL	341	Fundamental Genetics	4
3.	Complete one of the following, either a. or b. (4 or 5 credits):			
a.	ANS	404	Advanced Animal Genetics	2
	ANS	425	Principles of Animal Biotechnology	3
b.	CSS	451	Biotechnology Applications for Plant Breeding and Genetics	4

Upon completion of the requirements for the Specialization in Agricultural and Natural Resources Biotechnology, the student should contact the Director of Academic Affairs of the College of Agriculture and Natural Resources and request certification for the completion of the specialization. After the certification is approved by the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

SPECIALIZATION IN CONNECTED LEARNING IN AGRICULTURE AND NATURAL RESOURCES

The Specialization in Connected Learning in Agriculture and Natural Resources will be available as an elective to undergraduate students whom the college has identified as Liberty Hyde Bailey Scholars. The specialization will be administered by the College of Agriculture and Natural Resources. The Director of the Liberty Hyde Bailey Scholars Program coordinates the specialization on behalf of the Dean.

The specialization provides an opportunity for students to develop life-long learning skills and motivations that should positively influence their intellectual and self-development, interpersonal skills, and ethical choice making. Each student participates actively in the learning journey by developing individualized plans of study and assessment as part of the requirements for the courses in the specialization. The capstone experience for the specialization consists of preparing and presenting a learning portfolio that documents and reflects upon the learning experiences accomplished during the student's learning journey.

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

Requirements for the Specialization in Connected Learning in Agriculture and Natural Resources

				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 Connected Learning	3
	ANR	310	Connected Learning Seminar I	3
	ANR	410	Connected Learning Transitions	3
b.	At least 12 additional credits in approved courses. A list of approved courses is available from the Director.			

Upon completion of the requirements for the Specialization in Connected Learning in Agriculture and Natural Resources, the student should contact the Director of Academic Affairs of the College of Agriculture and Natural Resources and request certification for the completion of the specialization. After the certification is approved by the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

SPECIALIZATION IN SUSTAINABLE AGRICULTURE AND FOOD SYSTEMS

The Specialization 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 specialization 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 specialization 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 Crop and Soil Sciences in advance and in writing.

Requirements for the Specialization in Sustainable Agriculture and Food Systems

				CREDITS
The student must complete 13 credits from the following:				
1.	Both of the following courses (4 credits):			
	CSS	124	Introduction Sustainable Agriculture andFood Systems	1
	CSS	424	Sustainable Agriculture and Food Systems: Integration and Synthesis	3
2.	Three of the following courses, including at least one course from the agricultural sciences and one course from the social sciences (9 credits):			
	Agricultural Sciences			
	CSS	101	Introduction to Crop Science	3
	CSS	360	Soil Biology	3
	CSS	431	International Agricultural Systems	3
	ENT	479	Organic Pest Management	3
	HRT	203	Principles of Horticulture	3
	HRT	251	Organic Farming Principles and Practices	3
	HRT	341	Vegetable Production and Management	3
	Social Sciences			
	EEP	255	Ecological Economics	3
	EEP	260	World Food, Population and Poverty	3
	ESA	343	Community Food and Agricultural Systems	3
	ESA	444	Pesticides, People and Politics	3
	GEO	410	Geography of Food and Agriculture	3
	RCAH	292B	Engagement and Reflection (D)	3

Upon completion of the requirements for the Specialization in Sustainable Agriculture and Food Systems, the student should contact the Department of Crop and Soil Sciences and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Crop and Soil Sciences and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

TEACHER CERTIFICATION OPTIONS

The agriscience disciplinary major leading to the Bachelor of Science degree in the College of Agriculture and Natural Resources is available for teacher certification.

Agriscience and environmental science disciplinary minors in the College of Agriculture and Natural Resources are also available for teacher certification.

In addition, vocational endorsement in agricultural education is available to persons who meet specified requirements.

Students who elect the agriscience disciplinary major, or the agriscience disciplinary minor, must contact the Department of Community, Agriculture, Recreation and Resource Studies.

Students who elect the environmental science disciplinary minor must contact the Department of Fisheries and Wildlife.

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 economics; animal science; biosystems engineering; construction management; community, agriculture, recreation and resource studies; 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; and plant pathology. 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 two areas: (1) environmental design and (2) interior design and facilities management.

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 economics; agricultural engineering; animal science; biosystems engineering; community, agriculture, recreation and resource studies; construction management; crop and soil sciences; entomology; fisheries and wildlife; food science; forestry, horticulture; human nutrition; human nutrition—environmental toxicology; 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; and plant pathology.

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 departments of Plant Pathology; Crop and Soil Sciences; Entomology; Fisheries and Wildlife, Forestry, and Horticulture are affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For additional information, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior in the *College of Natural Science* section of this catalog.

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

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 of Science degree programs in the departments of Plant Pathology; Crop and Soil Sciences; Entomology; Fisheries and Wildlife; Forestry or Horticulture may elect a Specialization in Ecology, Evolutionary Biology and Behavior. For additional information, refer to the statement on the specialization in the *College of Natural Science* 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, Packaging, and Plant Pathology 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 a elect 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 a elect Specialization in Environmental and Resource Economics. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Environmental and Resource Economics.*

Students who are enrolled in master's and doctoral degree programs at Michigan State University may elect a Specialization in Food and Agricultural Standards. For additional information, refer to the statement on *Graduate Specialization in Food and Agricultural Standards* in the *College of Social Science* section of this catalog.

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 an oral final examination on the program of study and research before a committee selected by the major professor and approved by the department chairperson. The committee consists of at least three members including the major professor and at least one member from another department. Other faculty members may attend at the department chairperson's or school director's discretion.

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

Academic Standards

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

Residence

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

Doctor of Philosophy

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

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

Admission

Acceptance of an applicant is determined by the department in which the applicant wishes to do his or her major work, with the approval of the dean of the college, after consideration of the applicant's academic record, experience, personal qualifications, and objectives. Applicants who are admitted are classified in one of two groups: **regular**, for students whose records and qualifications show that they are ready to pursue a course of study toward the doctorate, or **provisional**, for students who, although their previous work appears to have been at an acceptably high academic level, nevertheless lack some important requirements for the course of study they intend to follow toward the doctorate. Such deficiencies will often necessitate the completion of collateral courses for which credit will not be counted toward the degree.

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

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

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

Examinations

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

FINAL. The final oral examination, primarily in defense of the dissertation, is conducted by the guidance committee, supplemented, at the discretion of the dean, by two appointed faculty members. Other faculty members may attend at the chairper-

son'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 academic 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 Engineering, 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, Civil and Environmental Engineering, Community, Agriculture, Recreation and Resource Studies, Crop and Soil Sciences, Entomology, Fisheries and Wildlife, Food Science and Human Nutrition, Geological Sciences, Pathobiology and Diagnostic Investigation, 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 course (3 credits):			
	RD	836	Legal Aspects of Environmental Regulation	3
3.	Complete one of the following courses (3 or 4 credits):			
	ANS	827	Integrated Risk Assessment of Environmental Hazards	3
	ZOL	814	Environmental Chemodynamics	4
4.	Complete one of the following courses (3 credits):			
	PHM	450	Introduction to Chemical Toxicology	3
	PHM	814	Advanced Principles of Toxicology	3
5.	Complete one course from any of the five categories listed below (1 to 4 credits):			
	Environmental Dynamics			
	CE	481	Environmental Engineering Chemistry	3
	CE	821	Groundwater Hydraulics	3
	CSS	455	Pollutants in the Soil Environment	3
	CSS	855	Interfacial Environmental Chemistry	4
	ENE	801	Dynamics of Environmental Systems	3
	GLG	421	Environmental Geochemistry	4
	GLG	821	Aqueous Geochemistry	3
	MMG	425	Microbial Ecology	3
	MMG	841	Soil Microbiology	3
	ZOL	878	Dynamics of Trace Contaminants in Aquatic Systems	3
	ZOL	897	Ecosystem Ecology	4
	Economics, Policy, and Law			
	AEC	810	Institutional and Behavioral Economics	3
	AEC	829	The Economics of Environmental Resources	3
	RD	415	Environmental Impact Assessment	4
	RD	828	Attitudes, Behavior and Environmental Sustainability	3
	Waste Management			
	CE	483	Water and Wastewater Treatment	3
	CE	485	Solid and Hazardous Waste Management	3
	CE	487	Microbiology for Environmental Health Engineering	3
	ENE	804	Biological Processes in Environmental Engineering	3
	ENE	807	Environmental Analytical Chemistry	3
	ENE	808	Environmental Analytical Chemistry Laboratory	1
	Analytical Chemistry			
	CEM	835	Spectrochemical Methods of Analysis	3
	CEM	836	Separation Science	3
	CEM	845	Structure and Spectroscopy of Organic Compounds	3
	ENT	940	Analytical Techniques for Bioactive Compounds: Separation	4
	ENT	941	Analytical Techniques for Bioactive Compounds: Confirmation	4
	Mechanisms of Toxicity			
	ANS	407	Food and Animal Toxicology	3
	BMB	960	Selected Topics in Biochemistry I	1 to 7
	FSC	807	Advanced Food Toxicology	3
	FSC	840	Advanced Food Microbiology	3
	OSS	512	Biostatistics and Epidemiology	2
	PHM	815	Concepts in Tumorigenesis	2
	PTH	856	Concepts in Toxicologic Pathology	2
	ZOL	868	Aquatic Toxicology	4
	Biochemistry and Molecular Biology 960 may be counted toward the requirements for the specialization only when the topic deals with environmental toxicology.			
6.	Attend a minimum of six seminars in environmental toxicology.			

Upon completion of the requirements for the master's degree and the requirements for the Specialization in Environmental Toxicology, the student should contact the chairperson of the department that administers the student's degree program and request certification for the completion of the specialization. After the certification is approved by the chairperson of the department and the Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

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 combin-

ing 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 two 1-credit enrollments in the following course:			
	FW	893	Seminar in Fisheries and Wildlife	2
2.	Complete the following capstone course:			
	FW	823	Wildlife Disease Ecology and Management	3
3.	Complete one course from each of the following topic areas:			9 to 11
	Pathology and Disease			
	FW	423	Principles of Fish and Wildlife Disease	3
	FW	423L	Principles of Fish and Wildlife Disease Laboratory	1
	FW	822	Aquatic Animal Medicine	3
	MMG	567	Veterinary Microbiology and Infectious Disease I	5
	MMG	569	Veterinary Microbiology and Infectious Disease II	5
	PTH	551	General Pathology	3
	Students who select Fisheries and Wildlife 423 must also enroll in Fisheries and Wildlife 423L concurrently.			
	Epidemiology and Quantitative Methods			
	EPI	810	Introduction to Descriptive and Analytical Epidemiology	3
	FW	824	Analysis of Wildlife Populations	3
	VM	533	Veterinary Epidemiology	3
	Policy and Management			
	FW	434	Human Dimensions of Fisheries and Wildlife Management	3
	FW	811	Fisheries and Wildlife Laws and Regulations	3
	FW	884	Outreach in Fisheries, Wildlife and Natural Resource Management	3
4.	Master's students will complete a thesis reflecting the integration of the student's discipline.			

Upon completion of the requirements for the degree and the requirements for the Graduate Specialization in Fish and Wildlife Disease Ecology and Conservation Medicine, the student shall contact the Chairperson of the department that administers the student's degree program and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department and the Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

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

Upon completion of the requirements for the Graduate Specialization in Gender, Justice, and Environmental Change, the student should contact the Dean of the College of Agriculture and Natural Resources and request certification for the completion of the specialization. After the certification is approved by the Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date it was completed. This certification will appear on the student's transcript.

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.

Upon completion of the requirements for the degree program and the Interdepartmental Graduate Specialization in Environmental and Resource Economics, the student should contact the chairperson of the student's major department and request certification for the completion of the specialization. After the certification is approved by the chairperson of the department and the Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

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

Steven D. Hanson, Chairperson

UNDERGRADUATE PROGRAMS

The department offers three undergraduate majors: agribusiness management, environmental economics and policy, 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 to meet the needs of 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 Agribusiness Management 437. That course is referenced in item 3. a. below.
   The completion of the College of Agriculture and Natural Resources Mathematics requirement may also satisfy the University mathematics requirement.
2. The 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 course referenced in items 3. a. and in all courses taken to fulfill requirements 3. b. and 3. c.
   Agribusiness Management 427 may be used to fulfill requirement 3. b. if it is not used to fulfill requirement 3. c.
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	210	Professional Seminar in Agribusiness Management	1
	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
	ABM	437	Agribusiness Strategic Management (W)	3
	ACC	230	Survey of Accounting Concepts	3
	CSE	101	Computing Concepts and Competencies	3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
	FIM	220	Food Product Marketing	3
	MGT	325	Management Skills and Processes	3
	MSC	303	Introduction to Supply Chain Management	3
	MSC	327	Introduction to Marketing	3

Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.

b. Five of the following courses: 15
- ABM 130 Farm Management I 3
- ABM 222 Agribusiness and Food Industry Sales (W) 3
- ABM 332 Agribusiness Operations Management 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 430 Farm Management II 3
- EEP 405 Corporate Environmental Management 3
- FIM 424 Information and Market Intelligence in the Agri-Food Industry 3
- GBL 323 Introduction to Business Law 3
- RET 373 Retail Entrepreneurship 3

c. One of the following courses: 3
- ABM 427 Global Agri-Food Industries and Markets 3
- EEP 260 World Food, Population and Poverty 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. Additional courses in Animal Science, Crop and Soil Sciences, Horticulture and Environmental Economics and Policy as approved by the academic advisor 9

FOOD INDUSTRY MANAGEMENT

The food industry management major is designed to meet the needs of 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 Food Industry Management 439. That course is referenced in item 3. a. below.

   The completion of the College of Agriculture and Natural Resources Mathematics requirement may also satisfy the University mathematics requirement.
2. The 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 course referenced in items 3. a. including Marketing and Supply Chain Management 351, Retailing 460, and in all courses taken to fulfill requirements 3. b. and 3. d.

   Agribusiness Management 427 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: 42
- ABM 100 Decision-making in the Agri-Food System 3
- ACC 230 Survey of Accounting Concepts 3
- CSE 101 Computing Concepts and Competencies 3
- EC 201 Introduction to Microeconomics 3
- EC 202 Introduction to Macroeconomics 3
- FI 320 Introduction to Finance 3
- FIM 210 Professional Seminar in Food Industry Management 1
- FIM 220 Food Product Marketing 3
- FIM 410 Advanced Professional Seminar in Food Industry Management 1
- FIM 439 Food Business Analysis and Strategic Planning (W) 3
- MGT 325 Management Skills and Processes 3
- MSC 303 Introduction to Supply Chain Management 3
- MSC 327 Introduction to Marketing 3
- MSC 351 Retail Management 3
- RET 460 Retail Information Systems 4

Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.

b. Four of the following courses: 12
- ABM 222 Agribusiness and Food Industry Sales (W) 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 435 Financial Management in the Agri-Food System 3
- EEP 405 Corporate Environmental Management 3
- FIM 335 Food Marketing Management 3
- FIM 415 Human Resource Management: Changes and Challenges 3
- FIM 424 Information and Market Intelligence in the Agri-Food Industry 3

c. One of the following courses: 3
- ACC 202 Principles of Management Accounting 3
- GBL 323 Introduction to Business Law 3
- MSC 302 Consumer and Organizational Buyer Behavior 3
- RET 363 Promotional Strategies in Retailing 3
- RET 373 Retail Entrepreneurship 3
- RET 465 International Retailing 3

d. One of the following courses: 3
- ABM 427 Global Agri-Food Industries and Markets 3
- EEP 260 World Food, Population and Poverty 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. Additional courses in Food Science, Hospitality Business, Human Nutrition and Foods, Packaging, Retailing, and Environmental Economics and Policy as approved by the academic advisor 9

ENVIRONMENTAL ECONOMICS AND POLICY

Environmental Economics and Policy prepares students for careers that require balancing environmental sustainability and economic development. The major develops economic analysis skills and basic environmental science knowledge and applies these skills and knowledge to analyze the role of environmental considerations in economic decisions of governments, firms and households. The major prepares students for employment opportunities with state, federal and international government agencies, environmental interest groups, environmental consulting firms, and industry. The major also offers students the opportunity to prepare for graduate study in environmental economics or environmental policy studies programs.

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

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 Policy.

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

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The 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: 45
- ACC 230 Survey of Accounting Concepts 3
- CSE 101 Computing Concepts and Competencies 3
- EC 201 Introduction to Microeconomics 3
- EC 202 Introduction to Macroeconomics 3
- EEP 201 Community Economics 3
- EEP 255 Ecological Economics 3
- EEP 260 World Food, Population and Poverty 3
- EEP 320 Environmental Economics 3
- EEP 404 Public Sector Budgeting and Program Evaluation (W) 3
- EEP 405 Corporate Environmental Management 3
- GEO 221 Introduction to Geographic Information 3

	RD	430	Law and Resources	3
	RD	440	Environmental Policy Making in Michigan	3
	RD	460	Natural Resource Economics	3
	RD	470	Theory and Practice in Community and Economic Development	3
	Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.			
b.	One of the following courses:			3
	EC	335	Taxes, Government Spending and Public Policy	3
	EC	435	Public Expenditures	3
c.	One of the following courses:			3 or 4
	FW	203	Resource Ecology	3
	GLG	201	The Dynamic Earth	4
	ISB	202	Applications of Environmental and Organismal Biology	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.	Professional electives: At least 12 credits in applied policy courses approved in writing by the student's academic advisor.			

SPECIALIZATION IN AGRIBUSINESS MANAGEMENT

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

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 bachelor's degree.

Requirements for the Specialization 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	332	Agribusiness Operations Management	3
	ABM	430	Farm Management II	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	435	Financial Management in the Agri-Food System	3
	ABM	437	Agribusiness Strategic Management (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
	MSC	327	Introduction to Marketing	3
	RET	373	Merchandising Management Entrepreneurship	3

Upon completion of the requirements for the Specialization in Agribusiness Management, the student should contact the Chairperson of the Department of Agricultural, Food, and Resource Economics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Agricultural, Food, and Resource Economics and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

SPECIALIZATION IN ENVIRONMENTAL ECONOMICS

The Specialization in Environmental Economics is designed to serve students who are interested in the application of economics to environmental issues. The educational objectives of the specialization 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 specialization is available as an elective to all students who are enrolled in bachelor's degree programs at Michigan State University. The specialization is administered by the Department of Agricultural, Food, and Resource Economics.

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 bachelor's degree.

Requirements for the Specialization in Environmental Economics

The student must complete:

				CREDITS
1.	One of the following courses:			3 or 4
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
	EC	251H	Microeconomics and Public Policy	4
	EC	252H	Macroeconomics and Public Policy	3
2.	All of the following courses:			9
	EEP	255	Ecological Economics	3
	EEP	320	Environmental Economics	3
	RD	460	Natural Resource Economics	3
3.	One additional course related to environmental policy issues and approved by the academic advisor for environmental economics in the Department of Agricultural, Food, and Resource Economics.			

Upon completion of the requirements for the Specialization in Environmental Economics, the student should contact the Chairperson of the Department of Agricultural, Food, and Resource Economics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Agricultural, Food, and Resource Economics and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

SPECIALIZATION IN FOOD INDUSTRY MANAGEMENT

The Specialization 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 specialization is to provide students with a fundamental knowledge of business management in relation to the food industry.

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

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 bachelor's degree.

Requirements for the Specialization in Food Industry Management

The student must complete:

				CREDITS
1.	All 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	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	427	Global Agri-Food Industries and Markets	3
	ABM	435	Financial Management in the Agri-Food System	3
	EEP	405	Corporate Environmental Management	3
	FIM	439	Food Business Analysis and Strategic Planning (W)	3
	MSC	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
	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
	MSC	327	Introduction to Marketing	3

Upon completion of the requirements for the Specialization in Food Industry Management, the student should contact the Chairperson of the Department of Agricultural, Food, and Resource Economics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Agricultural, Food, and Resource Economics and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

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.

AGRICULTURAL, FOOD and RESOURCE ECONOMICS

Graduate programs in agricultural, food and resource economics provide for coordinated study in several areas. The courses and programs are designed to help students become thoroughly grounded in the concepts and tools of economics and related fields and to enable them to solve practical problems. The department offers the following five fields of study: agribusiness strategy and management, agricultural markets and price analysis, environmental and resource economics, finance and production economics, and international agricultural development.

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.

Courses in agricultural, food and resource economics, mathematics, statistics, and related areas are available for those students who wish to begin or continue their graduate work during the summer months.

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 (nonthesis 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 3.00 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 that the department has identified as containing primarily economic theory.
4. A minimum of 9 credits in courses in quantitative analysis, including 3 credits of mathematics for economists (equivalent to AEC 801) and one elective 3 credit quantitative methods course. Alternatively, students may replace AEC 801 by 1 credit of mathematics for economists (equivalent to AEC 800A) and a second 3 credit elective quantitative methods course for a total of 10 credits in quantitative analysis.

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 nor more than 4 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:

1. Acquire (a) competence in economics by completing 9 credits of Ph.D. level courses in economic theory and (b) 9 credits in a major field in one of the five fields within agricultural, food and resource economics referenced above.
2. Pass written comprehensive examinations in economics no later than the end of the second academic year and in the student's chosen major field by the end of the third academic year.
3. Complete (a) 6 credits in a minor field in agricultural, food and resource economics outside the major field, and (b) 6 credits in a second minor field that may be outside the Department of Agricultural, Food, and Resource Economics.
4. Acquire competence in quantitative methods by taking specified courses in mathematics for economists (3 credits), probability and statistics (3 credits), econometrics (3 credits) and one other quantitative methods course (3 credits). A grade of 3.0 must be achieved in each course.
5. Complete one graduate course (3 credits) in research methodology.
6. Complete 24 credits of dissertation research, present and obtain formal approval for the proposed dissertation research, 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.

The student's dissertation research forms a part of the department's research program and contributes to it. Dissertation research may be conducted overseas in conjunction with university projects or with the support of other research grants. A detailed description of master's and doctoral program requirements and a timetable for completing them are included in the *Graduate Education Policies* document of the Department of Agricultural, Food, and Resource Economics.

MASTER'S SPECIALIZATION IN AGRIBUSINESS

The Master's specialization in Agribusiness is designed to serve students who are interested in careers in agribusiness. The specialization is available as an elective to students who are enrolled in master's degree programs in the College of Agriculture and Natural Resources, The Eli Broad Graduate School of Management, and the College of Veterinary Medicine. The specialization is administered by the Department of Agricultural, Food, and Resource Economics.

The student's program of study for the specialization must be approved by the academic advisor for agribusiness. Through the selection of courses, the specialization complements the student's master's degree program. Students in agriculturally related disciplines complete courses in business management, marketing, finance, and human resource management as applied to agribusiness firms. Students in business management fields complete courses in agribusiness.

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 Master's Specialization in Agribusiness

The student must complete:

				CREDITS
1.	One of the following courses:			3
	AEC	800	Foundations of Agricultural Economics	3
	EC	805	Microeconomic Analysis	3
	Requirement 1. will be waived for students who have completed an intermediate-level course in microeconomics.			
2.	Two of the following courses:			6
	AEC	851	Agricultural Firm Management	3
	AEC	853	Financial Management in Agriculture	3
	AEC	857	Strategic Management in Agribusiness	3
	Agricultural Economics 851 or 853 or 857 may be used to satisfy *either* requirement 2. *or* requirement 3., but not both of those requirements.			
3.	Two of the following courses:			6
	ACC	800	Financial Accounting Concepts	3
	ACC	840	Managerial Accounting	3
	AEC	817	Political Economy of Agricultural and Trade Policy	3
	AEC	831	Food Marketing Management	3
	AEC	839	Applied Operations Research	3
	AEC	841	Analysis of Food System Organization and Performance	3
	AEC	845	Commodity Market Analysis	3
	AEC	851	Agricultural Firm Management	3
	AEC	853	Financial Management in Agriculture	3
	AEC	855	Agricultural Production Economics	3
	AEC	857	Strategic Management in Agribusiness	3
	GBL	848	Legal Environment of Business	3
	LIR	823	Organizational Behavior in Labor and Industrial Relations	3
	LIR	824	Human Resource Strategies and Decisions	3
	LIR	825	Compensation and Benefit Systems	3
	LIR	858	Collective Bargaining	3
	MGT	806	Management and Organizational Behavior	3
	MGT	810	Human Resource Management	3
	MSC	800	Materials and Logistics Management	3
	MSC	805	Marketing Management	3
	MSC	806	Marketing Analysis	3
	MSC	808	Entrepreneurial Marketing	3
	MSC	813	Marketing Research Methods	3
	VM	541	Veterinary Perspectives III	2

Either Labor and Industrial Relations 823 *or* Management 806, but not both of those courses, may be used to satisfy requirement 3.

Either Labor and Industrial Relations 824 *or* Management 810, but not both of those courses, may be used to satisfy requirement 3.

Veterinary Medicine 541 may be used to satisfy requirement 3. *only if* the student also completes 1 additional credit in an approved Veterinary Medicine course.

Upon completion of the requirements for the master's degree in one of the colleges specified above and the requirements for the Master's Specialization in Agribusiness, the student should contact the chairperson of the department that administers the student's degree program and request certification for the completion of the specialization. After the certification is approved by the chairperson of the department and the Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

DEPARTMENT of ANIMAL SCIENCE

Karen I. Plaut, 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 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

Ajit Srivastava, Chairperson

The Department of Biosystems and Agricultural Engineering is administered jointly by the College of Agriculture and Natural Resources and the College of Engineering.

UNDERGRADUATE PROGRAMS

The department offers a Bachelor of Science degree program with a major in technology systems management through the College of Agriculture and Natural Resources. That program is described below.

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.

TECHNOLOGY SYSTEMS MANAGEMENT

Bachelor of Science

The Technology Systems Management program is designed to meet the needs of students who aspire to apply new technology to solve problems in food, agricultural and biological systems. Prospective students should have an affinity for physical systems, computers, and technology, and they should be practical problem-solvers.

Students in the program acquire a strong technical background tempered by an overview of business and economics. They possess highly portable skills in technology transfer and technical problem-solving which are applicable to many related career paths.

Graduates find employment as agricultural and environmental research technicians, managers of processing and production facilities, technical sales representatives, and service and marketing managers for equipment manufacturers.

Requirements for the Bachelor of Science Degree in Technology Systems 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 Technology Systems Management.

   The University's Tier II writing requirement for the Technology Systems Management major is met by completing Technology Systems Management 481. That course is referenced in item 3. a. below.

   Students who are enrolled in the Technology Systems Management major leading to the Bachelor of Science degree in the Department of Biosystems and Agricultural Engineering may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of Chemistry 161, Physics 231 and 251, and one of the following courses: Biological Science 110 or 111; Entomology 205; Microbiology and Molecular Genetics 205; Physiology 250; or Plant Biology 105. The completion of Physics 251 or Biological Science 110 satisfies the laboratory requirement.

   The completion of Mathematics 124 satisfies both the College of Agriculture and Natural Resources mathematics requirement 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.
3. The following requirements for the major:

				CREDITS
a.	All of the following courses:			56
	ABM	100	Decision-making in the Agri-Food System	3
	ABM	332	Agribusiness Operations Management	3
	CEM	141	General Chemistry	4
	CEM	161	Chemistry Laboratory I	1
	CSE	101	Computing Concepts and Competencies	3
	GEO	221	Introduction to Geographic Information	3
	MTH	124	Survey of Calculus I	3
	PHY	231	Introductory Physics I	3
	PHY	251	Introductory Physics Laboratory I	1
	TSM	121	Fundamentals of Electricity	4
	TSM	122	Alternating and Direct Current Machines	3
	TSM	223	Fundamentals of Automation and Controls	4
	TSM	224	Digital Systems, Sensors and Measurement	3
	TSM	341	Power and Machinery Systems	3
	TSM	342	Power and Control Hydraulics	3
	TSM	343	Implementation of Precision Agriculture	3
	TSM	351	Information Technology in Agricultural Systems	3
	TSM	481	Technology Systems Management – Capstone I (W)	3
	TSM	482	Technology Systems Management – Capstone II	3
	Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.			
b.	One of the following courses:			3 or 4
	BS	110	Organisms and Populations	4
	BS	111	Cells and Molecules	3
	ENT	205	Pests, Society and Environment	3
	MMG	205	Allied Health Microbiology	3
	PLB	105	Plant Biology	3
	PSL	250	Introductory Physiology	4
c.	One of the following courses:			3
	COM	100	Human Communication	3
	COM	225	An Introduction to Interpersonal Communication	3
d.	One of the following courses:			3 or 4
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
e.	One of the following courses:			3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
f.	One of the following courses:			3
	FI	320	Introduction to Finance	3
	GBL	323	Introduction to Business Law	3
	MGT	325	Management Skills and Processes	3
	MSC	327	Introduction to Marketing	3
g.	Cognate. The student must complete a minimum of 15 credits in an approved group of courses that includes courses in the College of Agriculture and Natural Resources. These courses must be chosen to form a career objective and be pre-approved by the student's academic advisor.			15

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 3.50 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 an external accredited institution. 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	Instrumentation for Biosystems Engineering	3
BE	820	Research Methods in Biosystems Engineering	1
BE	825	Properties and Characteristics of Biological Materials	3
BE	835	Engineering Analysis and Optimization of Biological Systems	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 Instrumentation for Biosystems Engineering. 3
      BE 820 Research Methods in Biosystems Engineering 1
      BE 825 Properties and Characteristics of Biological Materials 3
      BE 835 Engineering Analysis and Optimization of Biological Systems 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, AGRICULTURE, RECREATION and RESOURCE STUDIES

David E. Wright, Acting Chairperson

The Department of Community, Agriculture, Recreation and Resource Studies is an interdisciplinary department that offers programs leading to the Bachelor of Science, Master of Science, and Doctor of Philosophy degrees. The department's purpose is to educate scholars and practitioners who are trained to address current and future challenges across inter-related issues in natural resources, recreation, agriculture and communities.

The department has a multidisciplinary faculty committed to scholarly programs in four cross-cutting areas that assist the development of sustainable communities: natural resources and the environment; education, communication and leadership; community, food and agriculture; and recreation and tourism. The department's programs provide opportunities for students to obtain a broad, interdisciplinary education, apply theory in practice, and emphasize one or more interdisciplinary professional areas.

The department offers credit and non-credit courses, both on and off campus, for a variety of professionals. Workshops, virtual courses, study abroad programs, and seminars also are conducted to provide professional development opportunities.

UNDERGRADUATE PROGRAMS

AGRISCIENCE

This major provides a foundation for students seeking careers in the dynamic agricultural and natural resources industries. Organizing workshops and seminars, developing leadership programs for agribusiness and government agencies and for adults and youth in agriculture, and representing new product lines and services for private industry are some of the exciting careers available to agriscience graduates.

Farm organizations, private agribusinesses, and government agencies need men and women knowledgeable in a broad spectrum of agricultural disciplines. There are many professional opportunities in extension, government agencies, and private businesses as human resource directors, professional development coordinators, or public school teachers.

The Bachelor of Science Degree in Agriscience is available only to students who are pursuing teacher certification in Agriscience.

Requirements for the Bachelor of Science Degree in Agriscience

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 Agriscience.

   The University's Tier II writing requirement for the Agriscience major is met by completing Agriculture and Natural Resources 489 and Agriculture and Natural Resources Education and Communication Systems 410 and 411. Those courses are referenced in items 2. and 3. a. below.

   Students who are enrolled in the Agriscience major leading to the Bachelor of Science degree in the Department of Community, Agriculture, Recreation and Resource Studies may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 110, Chemistry 141, 143 and 161. The completion of Biological Science 110 and Chemistry 161 satisfies the laboratory requirement. Biological Science 110, 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 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:			50
	AEE	110	Foundations of ANR Communications: Learning and Leadership . . . 2	
	AEE	111	Applications of ANR Communications: Learning and Leadership . . . 2	
	AEE	210	Approaches to ANR Technology and Information Systems . . . 2	
	AEE	211	Applications of ANR Technology and Information Systems . . . 2	
	AEE	300	Approaches to Information Management and Evaluation in ANR . . . 2	
	AEE	311	Applications of Information Management and Evaluation in ANR . . . 2	
	AEE	410	Approaches to Problems in ANR Communications and Education . . . 2	
	AEE	411	Applications of Problems in ANR Communications and Education . . . 2	
	AEE	493	Professional Internship . . . 3	
	ANS	110	Introductory Animal Agriculture . . . 4	
	BS	110	Organisms and Populations . . . 4	
	BS	111	Cells and Molecules . . . 3	
	BS	111L	Cells and Molecular Biology Laboratory . . . 2	
	CEM	141	General Chemistry . . . 4	
	CEM	143	Survey of Organic Chemistry . . . 4	
	CEM	161	Chemical Laboratory I . . . 1	
	CSS	101	Introduction to Crop Science . . . 3	
	CSS	210	Fundamentals of Soil and Landscape Science . . . 3	
	HRT	203	Principles of Horticulture I . . . 2	
	HRT	203L	Principles of Horticulture I Laboratory . . . 1	
b.	One of the following courses:			3
	FOR	220	Forests and the Global Environment . . . 3	
	FW	203	Resource Ecology . . . 3	
	PRR	213	Introduction to Parks, Recreation and Leisure . . . 3	
	RD	201	Environmental and Natural Resources . . . 3	
	ZOL	355	Ecology . . . 3	
c.	One of the following courses:			3 or 4
	ANS	314	Genetic Improvement of Domestic Animals . . . 4	
	CSS	350	Introduction to Plant Genetics . . . 3	
	ZOL	341	Fundamental Genetics . . . 4	
d.	One of the following courses:			3
	ABM	100	Decision-making in the Agri-Food System . . . 3	
	ABM	130	Farm Management I . . . 3	
e.	The following concentration:			
	Teacher Certification (21 credits)			
	Please refer to the statement on Teacher Certification Options in the Department of Community, Agriculture, Recreation and Resource Studies.			
	TE	150	Reflections on Learning . . . 3	
	TE	250	Human Diversity, Power, and Opportunity in Social Institutions . . . 3	
	TE	302	Learners and Learning in Context - Secondary (W) . . . 4	
	TE	407	Teaching of Subject Matter to Diverse Learners - Secondary (W) . . . 5	
	TE	408	Crafting Teaching Practices - Secondary (W) . . . 6	

ENVIRONMENTAL STUDIES AND AGRISCIENCE

The Department of Community, Agriculture, Recreation and Resource Studies offers a Bachelor of Science degree program with a major in Environmental Studies and Agriscience. This program of study is concerned with who uses resources, how they use them, and how positive outcomes of use can be enhanced and negative impacts can be mitigated. The program is designed to educate a diverse assembly of professionals who will work across disciplines and at many levels to provide expertise and leadership in agricultural, environmental and natural resource professions. Students benefit from a broad range of interdisciplinary courses, as well as disciplinary courses carefully selected to enhance students' technical knowledge. Professional internships and study abroad experiences are encouraged to provide students with experiences beyond the classroom and the campus. Graduates of this program will be prepared to enter professions in environmental, natural resource and agricultural fields through careers in education, government, private industry, non-profit organizations, and public relations and communications or enter a professional or graduate school program upon completion of the bachelor's degree.

Students focus their studies by completing one of the interdisciplinary professional concentrations within the major designed to provide additional breadth and depth.

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

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 Agriscience.

   The University's Tier II writing requirement for the Environmental Studies and Agriscience major is met by completing Environmental Studies and Agriscience 401, 413 or 420. Those courses are referenced in item 3. b. below.

   Students who are enrolled in the Environmental Studies and Agriscience major leading to the Bachelor of Science degree in the Department of Community, Agriculture, Recreation and Resource Studies may complete an alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 110, Chemistry 141 and Zoology 355 and 355L. The completion of Biological Science 110 and Zoology 355L satisfies the laboratory requirement. Biological Science 110, Chemistry 141 and Zoology 355 and 355L 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:

				CREDITS
a.	All of the following courses:			16
	ACR	202	Problem Solving in Community, Agriculture, and Environmental Systems . . . 3	
	ACR	205	Agriculture and Natural Resources Communication Theory and Practice . . . 3	
	ACR	492	Senior Seminar . . . 1	
	ESA	200	Introduction to Environmental Studies and Agriscience . . . 3	
	ESA	312	Principles of Leadership for Environmental and Agriscience Professionals . . . 3	
	ZOL	355	Ecology . . . 3	
b.	One of the following courses:			3
	ESA	401	Communications Campaigns for Agricultural and Environmental Issues (W) . . . 3	
	ESA	413	Grantwriting and Fund Development (W) . . . 3	
	ESA	420	Risk and Decision Science for Environmental and Natural Resources Management (W) . . . 3	
c.	One of the following courses:			3 or 4
	COM	200	Methods of Communication Inquiry . . . 4	
	FW	324	Wildlife Biometry . . . 3	
	PSY	295	Data Analysis in Psychological Research . . . 3	
	STT	200	Statistical Methods . . . 3	
	STT	201	Statistical Methods . . . 4	
d.	One of the following courses:			3 or 4

CSS 210 Fundamentals of Soil Science . . . 3
GLG 201 The Dynamic Earth . . . 4

e. One of the following courses: . . . 3
ABM 100 Decision-making in the Agri-Food System . . . 3
ABM 130 Farm Management I . . . 3
EEP 255 Ecological Economics . . . 3

f. One of the following courses: . . . 3 or 4
ANS 110 Introductory Animal Agriculture . . . 4
FW 205 Principles of Fisheries and Wildlife Management . 3
ZOL 313 Animal Behavior . . . 3

g. One of the following courses: . . . 2 to 4
CSS 101 Introduction to Crop Science . . . 3
FOR 202 Introduction to Forestry . . . 3
FOR 204 Forest Vegetation . . . 4
HRT 203 Principles of Horticulture I . . . 2
PLB 105 Plant Biology . . . 3

h. One of the following courses or fulfillment of an experiential education experience: . . . 3 to 6
ESA 475 Agriscience and Natural Resources Studies Abroad . . . 3
ESA 480 Environmental Studies Abroad . . . 3
ESA 493 Professional Internship in Environmental Studies and Agriscience . . . 3 to 6
Completion of an experiential education course approved by the department.

i. An additional 6 credits at the 300-level or above . . . 6
Students may select courses from the College of Agriculture and Natural Resources, the College of Natural Science, the College of Social Science, or others as approved by the student's advisor. The courses used to satisfy requirements in items 3. c. through 3. i. may not be used to satisfy any other requirement for the major.

j. Concentration: . . . 19 to 24
Students must select one of the following concentrations: Communication; Community Engagement and Education; or Science and Policy.

Communication

Students who select the Communication concentration will be prepared for careers in agricultural, natural resource, and environmental journalism, public relations, advertising, or marketing communications. Professionals combine agriculture, natural resource and environmental subject-matter knowledge with skills in writing, speaking, layout and design, and information management. Colleges, advertising and public relations agencies, trade associations, government agencies, extension services, and corporations need professionals who can work in this field. Success in these organizations may lead to positions as editors, advertising account supervisors, public relations directors, and marketing communications managers.

1. One of the following courses: . . . 3 or 4
JRN 200 News Writing and Reporting I . . . 4
JRN 205 Writing for Media . . . 3

2. One of the following courses: . . . 3
WRA 320 Technical Writing . . . 3
WRA 341 Writing Nature and the Nature of Writing . . . 3

3. Four of the following courses: . . . 12 to 13
COM 240 Introduction to Organizational Communication 4
COM 275 Effects of the Mass Communication . . . 3
COM 325 Interpersonal Influence and Conflict . . . 3
ESA 412 Special Topics in Leadership and Education . 3
ESA 420 Risk and Decision Science for Environmental and Natural Resource Management (W) . . 3
FIM 424 Information and Market Intelligence in the Agri-Food Industry . . . 3
PRR 451 Interpretation and Visitor Information Systems . . . 3
TSM 251 Information Technology in Agricultural Systems . . . 3
WRA 210 Introduction to Web Authoring . . . 3

Community Engagement and Education

Students who select the Community Engagement and Education concentration will develop and conduct educational programs in non-formal settings, assist with formal, school-based educational programs, organize workshops and seminars, develop leadership programs for agribusiness, government agencies, recreation organizations and non-profits, and design environment, natural resource, agriculture, and recreation education and outreach programs for adults and youth in a variety of settings. There are many professional opportunities in non-profit organizations, trade associations, and federal, state and local government agencies, as well as volunteerism.

1. All of the following courses: . . . 13
ACR 415 Program Planning and Evaluation . . . 3
ESA 335 Engaged Learning and Teaching . . . 3
ESA 434 Professional Skills for Nonformal Educators . . 3
ESA 435 Conservation Education . . . 3
ESA 436 Conservation Education Practice . . . 1

2. Two of the following courses: . . . 6
ESA 412 Special Topics in Leadership and Education . 3
ESA 413 Grantwriting and Fund Development (W) . . . 3
PRR 451 Interpretation and Visitor Information Systems . . . 3
TSM 251 Information Technology in Agricultural Systems . . . 3

Science and Policy

Students who select the Science and Policy concentration will build a strong, interdisciplinary foundation in science and policy related to the environment, natural resources and agriculture. Students may focus on agriscience and policy, or they may choose to focus on environmental science and policy. Creatively combining course work in environmental science and agriscience will also prepare students for leadership roles in an increasingly complex field. Students who select this concentration will find careers in federal, state and local government, nonprofit organizations and trade associations, and private industry and consulting.

1. One of the following courses: . . . 3 or 4
CSS 210 Fundamentals of Soil Science . . . 3
GLG 201 The Dynamic Earth . . . 4
The course used to satisfy the major requirements may not be used to satisfy this requirement.

2. One of the following courses: . . . 3
ABM 400 Public Policy Issues in the Agri-Food System . 3
ESA 440 Environmental and Natural Resource Policy in Michigan State University . . . 3
ESA 444 Pesticides, People and Politics . . . 3
FOR 466 Natural Resource Policy . . . 3

3. Two of the following courses: . . . 6
ABM 430 Farm Management II . . . 3
ESA 430 Environmental and Natural Resource Law . . . 3
ESA 460 Natural Resource Economics . . . 3
PRR 302 Environmental Attitudes and Concepts . . . 3

4. Two of the following courses: . . . 6 to 8
ACR 415 Program Planning and Evaluation . . . 3
ANS 418 Comprehensive Nutrient Management Planning . . . 3
ESA 324 Water Resource Management . . . 3
ESA 415 Environmental Impact Assessment . . . 4
ESA 450 Smart Growth and Strategic Land Use Decision Making . . . 3
ESA 452 Watershed Concepts . . . 3
FW 419 Applications of Geographic Information Systems . . . 4
GEO 221 Introduction to Geographic Information . . . 3
GEO 325 Geographic Information Systems . . . 3
UP 353 Land Use Planning . . . 4
UP 400 Special Topics in Urban Planning . . . 3
Students may not use both Environmental Studies and Agriscience 324 and 452 to fulfill this requirement.
Students may not use both Fisheries and Wildlife 419 and Geography 221 to fulfill this requirement.

5. One of the following courses: . . . 3
ANP 470 Food, Hunger and Society . . . 3
ESA 343 Community Food and Agricultural Systems . . 3
ESA 470 Theory and Practice in Community and Economic Development . . . 3
HRT 486 Biotechnology in Agriculture: Applications and Ethical Issues . . . 3

NATURAL RESOURCE RECREATION and TOURISM

The Department of Community, Agriculture, Recreation and Resource Studies offers a Bachelor of Science degree in Natural Resources 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. The Natural Resource Recreation and Tourism major is designed to prepare students for professional positions related to the enjoyment of the outdoors. Such positions include management of public parks, forests and protected areas, non-profit lands and other natural resources, 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 Natural Resource Recreation and Tourism major.

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

Requirements for the Bachelor of Science Degree in Natural Resource 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 Natural Resource Recreation and Tourism.

   The University's Tier II writing requirement for the Natural Resource Recreation and Tourism major is met by completing Park, Recreation and Tourism Resources 370. That course is referenced in item 3. a. below.

   The completion of the College of Agriculture and Natural Resources mathematics requirement may also satisfy the University mathematics requirement.
2. The 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:			28 to 31
	ACR	202	Problem Solving in Community, Agriculture and Environmental Systems	3
	ACR	205	Agriculture and Natural Resources Communication Theory and Practice	3
	ACR	415	Program Planning and Evaluation	3
	ACR	492	Senior Seminar	1
	GEO	221	Introduction to Geographic Information	3
	PRR	211	Introduction to Natural Resource Recreation	3
	PRR	214	Introduction to Travel and Tourism	3
	PRR	370	Administration and Operation of Park and Recreation Systems (W)	3
	PRR	493	Professional Internship in Natural Resource Recreation and Tourism	3 to 6
	PRR	495	Comprehensive Planning and Strategy Development in Natural Resource Recreation and Tourism	3
	Students must maintain a minimum 2.00 grade-point average in all ACR and PRR courses referenced in item 3. a.			
b.	One of the following courses:			3 or 4
	FW	419	Applications of Geographic Information Systems to Natural Resources Management	4
	GEO	325	Geographic Information Systems	3
c.	One of the following courses:			3 or 4
	PSY	295	Data Analysis in Psychological Research	3
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	224	Introduction to Probability and Statistics for Ecologists	3
d.	One of the following concentrations:			30 or 35

Natural Resource Recreation Management (30 credits):

Federal, state and local governments and non-profit and for-profit entities offer a variety of career opportunities in natural resource recreation management. These opportunities include careers in park and land management, recreation and conservation law enforcement, and nature and cultural interpretation. They involve management of resources including facilities such as campgrounds, trails and water resources for people who enjoy the outdoors. Natural resource recreation professionals often work in teams with wildlife biologists, foresters, landscape architects, archaeologists, and historians in resource planning, facility development, and visitor management. A key characteristic of their efforts is to optimize recreational experiences while providing sustainable opportunities.

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

ESA	200	Introduction to Environmental Studies and Agriscience	3
FOR	202	Introduction to Forestry	3
FW	101	Fundamentals of Fisheries and Wildlife Ecology and Management	3

(2) All of the following courses (21 credits):

BS	110	Organisms and Population	4
CSS	210	Fundamentals of Soil Science	3
ESA	324	Water Resource Management	3
FOR	412	Wildland Fire	2
PRR	448	Foundations of Natural Resource Based Recreation Management	3
PRR	449	Natural Resource Based Recreation Management Applications	3
ZOL	355	Ecology	3

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

ESA	440	Environmental and Natural Resource Policy in Michigan	3
FOR	466	Natural Resource Policy	3

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

ESA	401	Communication Campaigns for Agricultural and Environmental Issues	3
PRR	410	International Studies in Tourism, Parks and Recreation	3
PRR	451	Interpretation and Visitor Information Systems	3

Commercial Recreation and Tourism (35 credits):

Commercial recreation enterprises and the entire tourism system are increasingly important aspects of our state, regional, national and world economies. Sustainability in this growing economic sector is a crucial factor as the industry seeks graduates who provide short-term and long-term perspectives on efficient, responsible use of resources that are the foundation of a customer's willingness to pay for outdoor recreation experiences. Marinas, ski resorts, commercial campgrounds, charter boats, canoe or kayak liveries, and other direct providers as well as support businesses such as motels, recreation equipment retailers and manufacturers and travel service providers, depend on a healthy, productive natural-resource base to attract and retain customers. Government entities such as visitor and convention bureaus, state travel bureaus and private sector tourism associations are increasingly active in marketing natural resource recreation and tourism opportunities to sustain and diversify local economies. Careers include marketing, enterprise development and management, guiding and outfitting, and association management, which provides a bridge between public and private sectors such as concessionaires providing commercial recreation services on public lands.

(1) One of the following courses (6 credits):

GEO	259	Geography of Recreation and Tourism	3
GEO	459	Tourism in Regional Development	3
PRR	272	Recreational Boating Systems and the Boating Industry	3
PRR	410	International Studies in Tourism, Parks and Recreation	3

(2) All of the following courses (32 credits):

ACC	230	Survey of Accounting Concepts	3
FI	320	Introduction to Finance	3
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
MGT	325	Management Skill and Process	3
MKT	327	Introduction to Marketing	3
PRR	360	Marketing Communications in Recreation and Tourism	3
PRR	473	Commercial Recreation and Tourism Businesses and Organizations	3
PRR	474	The Tourism System	3

SPECIALIZATION IN NATURAL RESOURCE RECREATION

The Specialization in Natural Resource Recreation is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University. It includes the management of land, water, forests, fisheries and wildlife and agriculture and is targeted toward students considering careers in public parks and recreation, commercial recreation enterprise management, forestry, fisheries, wildlife, criminal justice (conservation or recreation law enforcement), environmental policy, environmental management, landscape architecture, and agriculture. This specialization offers an opportunity for students to integrate study of social, biological and physical sciences, natural resources and ecosystems for the management of outdoor recreation.

Requirements for the Specialization in Natural Resource Recreation

With the approval of the department that administers the student's degree program, courses that are used to satisfy the requirements for the specialization may also be used to satisfy the requirements for the bachelor's degree. The student must meet the requirements specified below:

				CREDITS
1.	One of the following courses (3 credits):			
	PRR	210	Our National Parks and Recreation Lands	3
	PRR	302	Environmental Attitudes and Concepts	3
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
	ESA	200	Introduction to Environmental Studies and Agriscience	3
	FOR	202	Introduction to Forestry	3
	FW	205	Principles of Fisheries and Wildlife Management	3
	PRR	213	Introduction to Parks, Recreation and Leisure	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
	ESA	324	Water Resource Management	3
	ESA	430	Environmental and Natural Resource Law	3
	FOR	404	Forest and Agricultural 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
	FW	443	Restoration Ecology 3
	GEO	221	Introduction to Geographic Information 3
	PRR	388	Physical Resource Management in Parks, Recreation and Tourism 3
	PRR	451	Park Interpretive Services and Visitor Information Systems 3
	PRR	474	The Tourism System 3
	ZOL	355	Ecology 3
4.	Both of the following courses (6 credits):		
	PRR	448	Foundations of Natural Resource Based Recreation Management 3
	PRR	449	Natural Resource Based Recreation Management Applications 3

Upon completion of the requirements for the Specialization in Natural Resource Recreation, the student should contact the Chairperson of the Department of Community, Agriculture, Recreation and Resource Studies and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Community, Agriculture, Recreation and Resource Studies and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

TEACHER CERTIFICATION OPTIONS

The agriscience disciplinary major leading to the Bachelor of Science degree is available for teacher certification. Students who complete the requirements for the agriscience disciplinary major, the requirements for teacher certification, and a minimum of 4000 hours of recent and relevant work experience are recommended for vocational endorsement in agricultural education.

An agriscience disciplinary minor is available for teacher certification.

Students who elect the agriscience disciplinary major or the Agriscience disciplinary minor, must contact the Department of Community, Agriculture, Recreation and Resource Studies.

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, Agriculture, Recreation and Resource Studies offers Master of Science and Doctor of Philosophy degree programs in Community, Agriculture, Recreation and Resource Studies.

Graduate programs in Community, Agriculture, Recreation and Resource Studies provide students the opportunity to create individualized programs that draw from several complementary areas of scholarship. These areas include: community, food and agriculture; natural resources and the environment; recreation and tourism; and, communication and leadership. 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.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of Community, Agriculture, Recreation and Resource Studies 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, Agriculture, Recreation and Resource Studies may elect a Specialization in Environmental Toxicology. For additional information, refer to the *Graduate Specialization in Environmental Toxicology* statement.

Master of Science

The Master of Science in Community, Agriculture, Recreation and Resource Studies 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.

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, Agriculture, Recreation and Resource Studies. 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, Agriculture, Recreation and Resource Studies

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):
   - ACR 800 Foundations of Community, Agriculture, Recreation and Resource Studies 3
   - ACR 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, Agriculture, Recreation and Resource Studies 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, Agriculture, Recreation and Resource Studies 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:
   - ACR 895 Case Studies in Community, Agriculture, Recreation and Resource Studies 3
   - ACR 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, Agriculture, Recreation and Resource Studies 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, Agriculture, Recreation and Resource Studies, 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, Agriculture, Recreation and Resource Studies

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, Agriculture, Recreation and Resource Studies 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, Agriculture, Recreation and Resource Studies 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.

DEPARTMENT of CROP and SOIL SCIENCES

James J. Kells, Chairperson

UNDERGRADUATE PROGRAMS

The department offers two undergraduate majors, Crop and Soil Sciences and Environmental Soil Science. The Crop and Soil Sciences major includes three concentrations: agronomic sciences, turfgrass management, and advanced studies. Each program is built on a broad educational base with a core of professional courses and sufficient electives to allow students and advisors to tailor individualized programs.

The department also offers undergraduate specializations in agronomy and international agriculture.

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 Crop and Soil 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 Crop and Soil 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 to-

ward 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:			57 to 67

Agronomic Sciences (57or 58 credits):

(1) All of the following courses (52 credits):

CEM	141	General Chemistry	4
CEM	143	Survey of Organic Chemistry	4
CSS	101	Introduction to Crop Science	3
CSS	192	Professional Development Seminar I	1
CSS	302	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

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	Golf Turf Irrigation	3
CSS	181	Pesticide and Fertilizer Application Technology	3
CSS	232	Turfgrass Management	4
CSS	262	Turfgrass Management Seminar	1
CSS	267	Turfgrass Practices	2
CSS	269	Turfgrass Strategies	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	382	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	366	Turfgrass Pathology	3

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

HRT	361	Applied Plant Physiology	3
PLB	301	Introductory Plant Physiology	3

Advanced Study (59 credits):

(1) All of the following courses (62 credits):

BMB	401	Basic 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	192	Professional Development Seminar I	1
CSS	302	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) The following course:

STT	421	Statistics I	3

ENVIRONMENTAL SOIL SCIENCE

Requirements for the Bachelor of Science Degree in Environmental Soil 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 Environmental Soil Science.

   The University's Tier II writing requirement for the Environmental Soil Science major is met by completing all of the following courses: Crop and Soil Sciences 455 and 492. These courses are referenced in item 3.a. below.

   Students who are enrolled in the Environmental Soil Science major may complete an alternative track in Integrative Studies in Biological and Physical Sciences that consists of the following courses: Biological Science 111 and Chemistry 141, 142,161, and 162. The completion of Chemistry 161 and 162 satisfies the laboratory requirement. Biological Science 111 and Chemistry 141, 142, 161, and 162 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 also satisfies 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. may be counted toward College requirements as appropriate. The completion of Mathematics 132 satisfies the College's mathematics requirement.

3. The following requirements for the major:

				CREDITS
				74 to 76
a.	All of the following courses (60 credits):			
	BMB	200	Introduction to Biochemistry	4
	BS	111	Cells and Molecules	3
	CE	280	Principles of Environmental Engineering and Science	3
	CEM	141	General Chemistry	4
	CEM	142	General and Inorganic Chemistry	3
	CEM	143	Survey of Organic Chemistry	4
	CEM	161	Chemistry Laboratory I	1
	CEM	162	Chemistry Laboratory II	1
	CEM	262	Quantitative Analysis	3
	CSS	192	Professional Development Seminar I	1
	CSS	210	Fundamentals of Soil Science	3
	CSS	330	Soil Chemistry	2
	CSS	340	Applied Soil Physics	2
	CSS	455	Pollutants in the Soil Environment	3
	CSS	470	Soil Resources	3
	CSS	492	Professional Development Seminar II	1
	EC	201	Introduction to Microeconomics	3
	GLG	201	The Dynamic Earth	4
	GLG	411	Hydrogeology	3
	MMG	301	Introductory Microbiology	3
	MMG	425	Microbial Ecology	3
	MTH	132	Calculus I	3
b.	One course from each of the following *five* groups (14 to 16 credits):			
(1)	CE	485	Landfill Design	3
	CE	491	Civil Engineering Design Project	3
(2)	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	231	Statistics for Scientists	3
	STT	421	Statistics I	3
(3)	ANS	427	Environmental Toxicology and Society	3
	PHM	450	Introduction to Chemical Toxicology	3
(4)	NSC	448	Ecology, Law and Economics	3
	RD	430	Law and Resources	3
(5)	CSS	110	Computer Applications in Agronomy	2
	CSE	101	Computing Concepts and Competencies	3

Students who pass a waiver examination for Computer Science and Engineering 101 will not be required to complete Computer Science and Engineering 101 or Crop and Soil Sciences 110.

SPECIALIZATION IN AGRONOMY

This specialization is available as an elective to students who are enrolled in bachelor's degree programs at Michigan State University and 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 specialization 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.

Requirements for the Specialization in Agronomy

The student's program of study for the specialization must be approved by the Department of Crop and Soil Sciences in advance and in writing. With the approval of the department that administers the student's degree program, courses that are used to satisfy the requirements for the specialization may also be used to satisfy the requirements for the bachelor's degree. The student must meet the requirements specified below:

				CREDITS
1.	All of the following courses (9 credits):			
	CSS	101	Introduction to Crop Science	3
	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	151	Seed and Grain Quality	2
	CSS	201	Forage Crops	3
	CSS	212	Advanced Crop Production	2
	CSS	302	Principles of Weed Management	3
	CSS	380	Crop Physiology	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	440	Soil Biophysics	3
	CSS	470	Soil Resources	3

Upon completion of the requirements for the Specialization in Agronomy, the student should contact the Chairperson of the Department of Crop and Soil Sciences and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Crop and Soil Sciences and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

SPECIALIZATION IN INTERNATIONAL AGRICULTURE

This specialization 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, Crop and Soil Sciences, and Forestry, and the College of Social Science in cooperation with the Department of Anthropology participate in the Specialization in International Agriculture. The Department of Crop and Soil Sciences is the primary administrative unit.

Requirements for the Specialization in International Agriculture

The student's program of study for the specialization must be approved by the Department of Crop and Soil 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 specialization may also be used to satisfy the requirements for the bachelor's degree. The student must meet the requirements specified below:

				CREDITS
1.	**Foreign Language**. 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.			0 to 8
2.	**Study Abroad Experience**. Complete at least one study abroad experience that has a minimum duration of six weeks or two experiences of shorter duration.			6 to 12
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
	ANP	470	Food, Hunger and Society	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
	FOR	450	Forestry in International Development	3

Upon completion of the requirements for the Specialization in International Agriculture, the student should contact the Chairperson of the Department of Crop and Soil Sciences and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Crop and Soil Sciences and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

GRADUATE STUDY

The Department of Crop and Soil Sciences offers programs leading to Master of Science and Doctor of Philosophy degrees in crop and soil sciences and in plant breeding, genetics and biotechnology—crop and soil sciences. The department also offers a Doctor of Philosophy degree program in crop and soil sciences—environmental toxicology.

The Department of Crop and Soil Sciences is affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in the Department of Crop and Soil Sciences, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior in the *College of Natural Science* section of this catalog.

Students who are enrolled in Master of Science degree programs in the Department of Crop and Soil Sciences may elect specializations in ecology, evolutionary biology and behavior and in environmental toxicology. For additional information, refer to the statement on the Specialization in Ecology Evolutionary Biology and Behavior in the *College of Natural Science* section of this catalog, and to the *Graduate Specialization in Environmental Toxicology* statement.

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 Crop and Soil 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.*

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 Crop and Soil Sciences in advance and in writing.

Requirements for the Graduate Specialization in Ecological Food and Farming Systems

The student must complete 13 to 14 credits from the following:

				CREDITS
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.			

Upon completion of the requirements for the Graduate Specialization in Ecological Food and Farming Systems, the student should contact the Chairperson of the Department of Crop and Soil Sciences to request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Crop and Soil Sciences and the Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

DEPARTMENT of ENTOMOLOGY

Ernest S. Delfosse, Chairperson

The Department of Entomology is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science.

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 undergraduate program in Entomology leads to the Bachelor of Science degree. Courses are designed to give the student an understanding of the structure, classification, identification, function, biology, ecology, and management of beneficial and harmful arthropods, and the communities and ecosystems where insects occur.

There are opportunities for undergraduate Entomology students to carry out research projects in department laboratories. Students may also gain work experience in the diverse areas of entomology through employment during the academic year and summer. Internships and study abroad opportunities are also available, and are strongly encouraged.

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 470 or 478. Those courses are referenced in item 3. b. below.

   Students who are enrolled in the Entomology major concentrations may complete an alternative track to Integrative Studies in Biological and Physical Sciences by completing Entomology's mathematics and chemistry requirements and Biological Science 111. 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:

   a. All of the following courses (45 credits):

			CREDITS
BS	110	Organisms and Populations	4
BS	111	Cells and Molecules	3
CEM	141	General Chemistry	4
CEM	143	Survey of Organic Chemistry	4
CEM	161	Chemistry Laboratory I	1
CSE	101	Computing Concepts and Competencies	3
CSS	210	Fundamentals of Soil Science	3
ENT	404	Fundamentals of Entomology	3
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
ZOL	355	Ecology	3
ZOL	355L	Ecology Laboratory (W)	1

   One of the following courses:

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.

   Students who pass a waiver examination will not be required to complete Computer Science and Engineering 101.

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

ENT	470	General Nematology (W)	3
ENT	478	Pest Management II: Biological Components of Management Systems (W)	3

   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. At least 12 unique credits counted towards the requirements for a student's minor must not be used to fulfill the requirements for that student's major.

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

Requirements for the Minor in Entomology

Complete 15 credits from the following:

1. The following course (3 credits):

			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	469	Biomonitoring of Streams and Rivers	3
ENT	470	General Nematology (W)	3
ENT	478	Pest Management II: Biological Components of Management Systems (W)	3
ENT	479	Organic Pest Management	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 in entomology. It also offers a Professional Master of Science degree in Integrated Pest Management (Plan B). 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.

The Department of Entomology is affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in the Department of Entomology, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior.

Students who are enrolled in Master of Science degree programs in the Department of Entomology may elect specializations in ecology, evolutionary biology and behavior and in environmental toxicology. For additional information, refer to the statement on the Specialization in Ecology, Evolutionary Biology and Behavior and to the *Graduate Specialization in Environmental Toxicology* statement.

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.

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. 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

Both Plan A (with thesis) and Plan B (without thesis) are available, but students planning to earn a doctoral degree must follow Plan A. The student must complete a total of 30 credits for the degree under either Plan A or Plan B. Participation in the department's teaching program is also required.

Courses and thesis topic are planned on an individual basis by the student, the student's major professor, and the student's guidance committee. The following courses must be a part of the undergraduate or graduate program: a general entomology courses, systematics of adults or immatures, insect physiology or molecular entomology, and 2 credits of graduate seminar, Entomology 812. A final oral examination covering course work, research, and philosophical issues is required.

INTEGRATED PEST MANAGEMENT

Master of Science

The objective of this program is to train professionals in Integrated Pest Management with the business management and communication skills necessary for public and private sector employment. It is designed for students with bachelor's degrees in biological or agricultural sciences or for working professionals who wish to advance or change their careers.

Admission

In addition to meeting the requirements of the university and the College of Agriculture and Natural Resources, applicants are expected to have knowledge of computer applications and appropriate curricular background in crop protection-related fields and crop production-related fields. Applicants with good academic records who lack the expected curricular backgrounds may be admitted on a provisional basis but will be expected to take collateral course work.

Requirements for the Master of Science Degree in Integrated Pest Management

In addition to meeting the requirements of the University and the College of Agriculture and Natural Resources, the student must complete a total of 31 credits for the degree under Plan B (without thesis).

		CREDITS
1.	The following requirements for the major:	31
a.	Two of the following core courses (6 credits):	
	ENT 818 Systematics, Morphology, Biology: Adults . . . 3	
	or	
	ENT 838 Systematics, Morphology, Biology: Immatures . . . 3	
	ENT 850 Insect Physiology . . . 3	
	or	
	ENT 851 Molecular Entomology . . . 3	
b.	All of the following courses (19 credits):	
	Students will complete a total of three 1 credit seminars, focusing on standard topics for this program.	
	ENT 442 Concepts of Biological Information Systems . . . 3	
	ENT 477 Pest Management I: Pesticides in Management Systems . . . 3	
	ENT 478 Pest Management II: Biological Components of Management Systems(W) . . . 3	
	ENT 812 Graduate Seminar . . . 3	
	ENT 848 Biological Control of Insects and Weeds . . . 3	
	ENT 870 Nematode Management in Crop Systems . . . 3	
	ENT 890 Independent Study . . . 1	
c.	A minimum of two of the following courses (6 credits):	
	At least two courses must be from areas other than Entomology. The student's guidance committee may approve other courses to meet this requirement.	
	Requires special approval for application toward graduate credits.	
	BOT 362 Management of Turfgrass Pests . . . 4	
	BOT 407 Diseases and Insects of Forest and Shade Trees . . . 4	
	BOT 413 Virology . . . 3	
	BOT 810 Current Concepts in Plant Pathology . . . 3	
	BOT 812 Epidemiology of Plant Diseases . . . 3	
	BOT 847 Advanced Mycology . . . 4	
	BOT 884 Prokaryotic Diseases of Plants . . . 4	
	BOT 885 Plant Diseases in the Field . . . 2	
	CSS 310 Soil Management and Environmental Impact . . . 3	
	CSS 455 Pollutants in the Soil Environment . . . 3	
	CSS 805 Herbicide Action and Metabolism . . . 2	
	ENT 422 Aquatic Entomology . . . 3	
	ENT 460 Medical and Veterinary Entomology . . . 3	
	ENT 470 General Nematology (W) . . . 3	
	FOR 819 Advanced Plant Breeding . . . 3	
	FOR 838 Land Use Law . . . 3	
	FW 811 Fisheries and Wildlife Laws and Regulations . . . 3	
	FW 852 Systems Modeling and Simulation . . . 3	
	NSC 830 Nature and Practice of Science . . . 1	
d.	**Completion of a Certificate in Basic Business and Communication Skills**. The certificate program is organized as a series of week-end workshops covering such topics as project management, business law, intellectual property, management theory, finance, writing skills, presentation skills, information retrieval, interpersonal skills and group work. The certificate program offered by the faculty of The Eli Broad College of Business and the College of Communication Arts and Sciences, will include a case-study approach. It will involve an additional cost to the student beyond usual tuition and fees.	

After the completion of the certificate program is approved by The Eli Broad College of Business and by the Associate Dean of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the certificate program and the date it was completed. This certification will appear on the student's transcript upon completion of the requirements for the degree program.

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 master's degree including a thesis in an appropriate field of study is required. Subject matter training should be in the same general areas as required for admission to the Master of Science degree program in entomology. The student's past record must indicate maturity, reliability, and scholarly potential of a high order.

Requirements for the Doctor of Philosophy Degree in Entomology

A specified number of credits is not required, but early in the student's program the guidance committee, in consultation with the student, develops a list of proposed courses and a tentative dissertation subject. The student is expected to acquire a broad knowledge of entomology. The following courses must be a part of the undergraduate or graduate program: a general entomology course, systematics of adults or immatures, insect physiology or molecular entomology, insect ecology, evolution and conservation, 3 credits of Entomology 812 Graduate Seminar, and one course selected from a list of courses approved by the Department.

The student must pass a doctoral qualification examination which primarily consists of the defense of a dissertation proposal. Written and oral doctoral comprehensive examinations are required on philosophical issues and in the three or more areas of study specified by the guidance committee. Participation in the department's teaching program is also required.

In addition to the program developed by the guidance committee for a research specialty, the student must acquire an area of knowledge separate and distinct from those research competencies. The acquisition of this knowledge means a minimum of 10 credits or its equivalent. The area selected must be agreed upon, unanimously, by the guidance committee and the student.

DEPARTMENT of FISHERIES and WILDLIFE

Michael L. Jones, Acting Chairperson

UNDERGRADUATE PROGRAMS

Imagine yourself researching the impact of habitat loss on giant pandas in China, or studying the effects of a dam removal on a spawning salmon population. How about investigating the spread of Lyme disease by migrating birds, or examining the attitude of people towards increasing wolf populations in the Midwest? Or perhaps you're interested in conservation biology, or water pollution and public health, or marine biology, or environmental law. Opportunities within the fisheries and wildlife undergraduate program are endless.

Fisheries and wildlife management involves the maintenance and management of wild populations of fish and wildlife species and the ecosystems in which they live. But, 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 seven 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, preveterinary, and analytical foundations in fisheries and wildlife biology.

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.

Analytical Foundations in Fisheries and Wildlife Biology provides students an in-depth interdisciplinary view of the importance that chemical, physical and mathematical sciences play within the study of complex fisheries and wildlife issues.

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 by the Society of Wetland Scientists as a wetland professional-in-training.

Students who are enrolled in the Bachelor of Science degree program with a major in fisheries and wildlife may elect a specialization in agricultural and natural resources biotechnology, aquaculture, connected learning, conservation and environmental law enforcement, environmental economics, environmental studies, marine ecosystem management, museum studies, or spatial information processing. For additional information on any of these specialization, 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 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 Plant Biology 106 or Biological Sciences 111L or Lyman Briggs 144 and Chemistry 161 or Lyman Briggs 145 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 (8 or 9 credits):
   - (1) BS 110 Organisms and Populations 4
     PLB 105 Plant Biology 3
     PLB 106 Plant Biology Laboratory 1
   - (2) BS 110 Organisms and Populations 4
     BS 111 Cells and Molecules 3
     BS 111L Cells and Molecular Biology Laboratory 2
   - (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– Structure 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 271 Physics I 3
   - (2) CSS 210 Fundamentals of Soil Science. 3
     CSS 470 Soil Resources 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 to 8 credits):
   - (1) MTH 124 Survey of Calculus I 3
     MTH 132 Calculus I 3
     LB 118 Calculus I 5
   - (2) STT 231 Statistics for Scientists 3
     STT 224 Introduction to Probability and Statistics for Ecologists 3
     STT 421 Statistics I 3

e. One course from each group (6 credits):
   - (1) WRA 320 Technical Writing. 3
     WRA 331 Writing in the Public Interest 3
     WRA 341 Writing Nature and the Nature of Writing 3
     WRA 453 Grant and Proposal Writing. 3
   - (2) ESA 401 Communications Campaigns for Agricultural and Environmental Issues (W) 3
     FW 435 Integrated Communications for the Fisheries and Wildlife Professional 3
     JRN 412 Environmental Reporting. 3

f. One of the following courses (3 credits):
   - FW 438 Philosophy of Ecology (W) 3
   - PHL 340 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 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 3

h. All of the following courses (19 credits):
   - FW 101 Fundamentals of Fisheries and Wildlife Ecology and Management 3
   - FW 101L Fundamentals of Fisheries and Wildlife Ecology and Management Laboratory 2
   - FW 293 Undergraduate Seminar in Fisheries and Wildlife. . .
   - FW 364 Ecological Problem Solving. 3
   - FW 424 Population Analysis and Management 4
   - FW 434 Human Dimension of Fisheries and Wildlife Management 3
   - ZOL 355 Ecology 3

i. One of the following concentrations:

Conservation Biology (24 to 26 credits):
- (1) All of the following courses (9 credits):
  - FW 444 Conservation Biology 3
  - FW 443 Restoration Ecology 3
  - ZOL 445 Evolution (W). 3
- (2) One of the following courses (3 credits):
  - PLB 441 Plant Ecology 3
  - ZOL 370 Introduction to Zoogeography 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 479 Fisheries Management 3
- (5) One of the following courses (3 credits):
  - EEP 255 Ecological Economics 3
  - ESA 430 Environmental and Natural Resource Law . . . 3
  - FOR 464 Forest Resource Economics (W) 3
  - FW 481 Global Issues in Fisheries and Wildlife 3
  - FOR 466 Natural Resource 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 4
  - FW 471 Ichthyology 4
  - PLB 218 Plants of Michigan. 3
  - PLB 418 Plant Systematics 3
  - ZOL 360 Biology of Birds 4
  - ZOL 361 Michigan Birds. 4
  - ZOL 365 Biology of Mammals 4
  - ZOL 384 Biology of Amphibians and Reptiles (W). 4

Fisheries Biology and Management (25 to 27 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 470 Fisheries Techniques 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
- (4) One of the following courses (3 or 4 credits):
  - ENT 422 Aquatic Entomology 3
  - ZOL 306 Invertebrate Biology 4
- (5) One of the following courses (3 credits):
  - PLB 418 Plant Systematics 3
  - PLB 424 Algal Biology 3
- (6) One of the following courses (3 or 4 credits):
  - FW 473 Environmental Fish Physiology 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 (24 or 25 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) One of the following courses (4 credits):
- ZOL 360 Biology of Birds . . . 4
- ZOL 361 Michigan Birds . . . 4

(3) One of the following courses (4 credits):
- ZOL 365 Biology of Mammals . . . 4
- ZOL 384 Biology of Amphibians and Reptiles (W) . . . 4

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

(5) One of the following courses (4 credits):
- 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 27 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 Limnological Techniques . . . 3

(3) One of the following courses (3 credits):
- FW 414 Aquatic Ecosystem Management . . . 3
- FW 416 Marine Ecosystem Management . . . 3
- FW 479 Fisheries Management . . . 3

(4) One of the following courses (3 or 4 credits):
- 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):
- FW 454 Environmental Hydrology for Watershed Management . . . 3
- FW 473 Environmental Fish Physiology . . . 3
- GLG 303 Oceanography . . . 4
- GLG 421 Environmental Geochemistry . . . 4
- MMG 425 Microbial Ecology . . . 3
- MMG 426 Biogeochemistry . . . 3
- ZOL 341 Fundamental Genetics . . . 4
- ZOL 353 Marine Biology (W) . . . 4
- ZOL 483 Environmental Physiology (W) . . . 4

Fish and Wildlife Disease Ecology and Management (27 or 28 credits):

(1) All of the following courses (17 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
- MMG 301 Introductory Microbiology . . . 3
- ZOL 445 Evolution (W) . . . 3

(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 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 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 361 Michigan Birds . . . 4
- ZOL 365 Biology of Mammals . . . 4
- ZOL 384 Biology of Amphibians and Reptiles (W) . . . 4

Preveterinary (36 credits):

(1) All of the following courses (32 credits):
- ANS 313 Principles of Animal Feeding and Nutrition . . . 4
- 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
- MMG 301 Introductory Microbiology . . . 3
- MMG 302 Introductory Microbiology Laboratory . . . 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

Analytical Foundations of Fisheries and Wildlife Biology (24 to 29 credits):

(1) One course from each group (12 to 15 credits):
- (a) CEM 142 General and Inorganic Chemistry . . . 3
  - CEM 152 Principles of Chemistry . . . 3
  - LB 172 Principles of Chemistry II – Reactivity . . 3
- (b) LB 272 Physics II . . . 3
  - PHY 184 Physics for Scientists and Engineers II . 4
  - PHY 232 Introductory Physics II . . . 3
- (c) LB 119 Calculus II . . . 4
  - MTH 126 Survey of Calculus II . . . 3
  - MTH 133 Calculus II . . . 4
- (d) CSS 350 Introduction to Plant Genetics . . . 3
  - ZOL 341 Fundamental Genetics . . . 4

(2) The following course (3 credits):
- ZOL 445 Evolution (W) . . . 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 479 Fisheries Management . . . 3

(4) One of the following courses (3 or 4 credits):
- ENT 422 Aquatic Entomology . . . 3
- FW 471 Ichthyology . . . 4
- PLB 418 Plant Systematics . . . 3
- PLB 424 Algal Biology . . . 3
- ZOL 360 Biology of Birds . . . 4
- ZOL 361 Michigan Birds . . . 4
- ZOL 365 Biology of Mammals . . . 4
- ZOL 384 Biology of Amphibians and Reptiles (W) . . . 4

(5) Complete one additional 3 or 4 credits Fisheries and Wildlife course at the 300-level.

SPECIALIZATION IN CONSERVATION AND ENVIRONMENTAL LAW ENFORCEMENT

The Specialization in Conservation and Environmental Law Enforcement is designed to combine the natural resource expertise of the fisheries and wildlife, forestry, parks, recreation and tourism, and resource development programs, with the law enforcement expertise of the criminal justice program to serve those students with career interests in conservation or environmental law enforcement. The specialization is available as an elective to students who are enrolled in bachelor's degree programs in criminal justice, fisheries and wildlife, forestry, park, recreation and tourism resources, and resource development. The specialization 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 specialization may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Specialization in Conservation and Environmental Law Enforcement

The student must complete:

CREDITS

Natural Resources Conservation and Management . . . 5 or 6

1. One of the following courses (3 credits):
   - FOR 202 Introduction to Forestry . . . 3
   - FOR 220 Forests and the Global Environment . . . 3
   - FW 100 Introduction to Fisheries and Wildlife . . . 3
   - FW 205 Principles of Fisheries and Wildlife Management . . . 3
   - FW 284 Natural History and Conservation in Michigan . . . 3
   - PRR 210 Our National Parks and Recreation Lands . . . 3
   - PRR 213 Introduction to Parks, Recreation, and Leisure . . . 3
   - RD 200 Issues and Applications in Resource Development . . . 3
   - RD 201 Environmental and Natural Resources . . . 3
2. One of the following courses (2 or 3 credits):
   - FW 444 Conservation Biology . . . 3
   - FOR 310 Foundations of Forest Conservation . . . 2

PRR	449	Management of Natural Resource Based Recreation	3
RD	316	Land Use and Natural Resource Management	3
RD	320	Resource Management and Planning	3

Environmental Attitudes, Policy and Law . . . . . 6 or 7

One of the courses selected below must be from outside a student's major.

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

FW	434	Human Dimensions of Fisheries and Wildlife Management	3
FOR	230	Communicating Forestry Issues	3
PRR	302	Environmental Attitudes and Concepts	3
PRR	320	Human Behavior in Park and Recreation Settings	3
RD	300	Environmental Communication and Conflict Management	3

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

FOR	466	Natural Resources Planning and Policy	3
PHL	354	Philosophy of Law	3
PLS	305	Environmental Politics	3
RD	301	Federal and State Environmental Policy	3
RD	430	Law and Resources	3
RD	433	Law and Social Change	3
ZOL	446	Environmental Issues and Public Policy	3

Law Enforcement . . . . . 10 to 12

1. The following courses (4 credits):

CJ	110	Introduction to Criminal Justice	4

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

CJ	210	Introduction to Forensic Science	4
CJ	220	Criminology	4
CJ	292	Methods of Criminal Justice Research	4
CJ	335	Police Process	4
CJ	375	Criminal Law Process	4
CJ	433	Law Enforcement Intelligence Operations	3
CJ	435	Investigation Procedures	3
CJ	474	Law and Criminal Justice Policy	4

Upon completion of the requirements for the Specialization in Conservation and Environmental Law Enforcement, the student should contact the Chairperson of the Department of Fisheries and Wildlife and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Fisheries and Wildlife and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

SPECIALIZATION IN MARINE ECOSYSTEM MANAGEMENT

The Specialization 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 Specialization 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, Lyman Briggs School, Resource Development, and Zoology. The specialization 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 specialization 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 specialization should contact the undergraduate advisor for fisheries and wildlife in the Department of Fisheries and Wildlife.

Requirements for the Specialization 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
GLG	303	Oceanography	4
ZOL	353	Marine Biology	4
Biodiversity			
One of the following courses:			4
FW	462	Ecology and Management of Invertebrates	4
FW	471	Ichthyology	4
PLB	423	Wetland Plants and Algae	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 or 3
FW	480	International Studies in Fisheries and Wildlife	3
FW	493	Professional Internships in Fisheries and Wildlife	2 or 3
ZOL	453	Field Studies in Marine and Estuarine Biology	2 or 3
ZOL	496	Internship in Zoology	2 or 3
ZOL	498	Internship in Zoo and Aquarium Science	3

Upon completion of the requirements for the Specialization in Marine Ecosystem Management, the students should contact the Chairperson of the Department of Fisheries and Wildlife and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Fisheries and Wildlife and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

TEACHER CERTIFICATION OPTIONS

A environmental science disciplinary minor is available for teacher certification.

Students who elect the environmental science disciplinary minor, must contact the Department of Fisheries and Wildlife.

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

GRADUATE STUDY

The graduate program in the Department of Fisheries and Wildlife at Michigan State University is nationally and internationally recognized. 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.

Nationally and internationally recognized scientists visit the department, interacting with the faculty and students and presenting seminars. Graduate students have opportunities to attend regional and national professional meetings, such as the Midwest Fish and Wildlife Conference, the annual conferences of the American Fisheries Society and The Wildlife Society, and The North American Wildlife and Natural Resources Conference, in addition to meetings of the Michigan Chapter 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 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 within the department and guidance committees. 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. The department also offers a Doctor of Philosophy degree program in fisheries and wildlife—environmental toxicology.

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.

The Department of Fisheries and Wildlife is affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in the Department of Fisheries and Wildlife, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior in the *College of Natural Science* section of this catalog.

Students who are enrolled in the Master of Science degree program in the Department of Fisheries and Wildlife may elect specializations in ecology, evolutionary biology and behavior and in environmental toxicology. For additional information, refer to the statement on the Specialization in Ecology, Evolutionary Biology and Behavior in the *College of Natural Science* section of this catalog and to the *Graduate Specialization in Environmental Toxicology* statement.

Students who are enrolled in Master of Science and Doctor of Philosophy degree programs in the Department of 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.

DEPARTMENT of FOOD SCIENCE and HUMAN NUTRITION

Gale M. Strasburg, Chairperson

The Department of Food Science and Human Nutrition is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science.

UNDERGRADUATE PROGRAMS

The department offers Bachelor of Science degree programs with majors in dietetics and food science through the College of Agriculture and Natural Resources. These programs are described below.

The department also offers a Bachelor of Science degree program with a major in nutritional sciences through the College of Natural Science. For information about that program, refer to the statement on the *Department of Food Science and Human Nutrition* in the *College of Natural Science* section of this catalog.

Students who are enrolled in the Bachelor of Science degree program with a major in food 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.

DIETETICS

The undergraduate program in dietetics has been approved by the American Dietetic Association (ADA) 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 ADA 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 ADA 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 Approved ADA Didactic Program in Dietetics and one of the following supervised practice experiences: ADA Accredited Dietetic Internship, ADA Accredited Coordinated Program, or ADA Approved Preprofessional Practice 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 2.50 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 and 466. 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:			44
	HNF	150	Introduction to Human Nutrition	3
	HNF	300	Experimental Approaches to Foods	4
	HNF	320	Basic Skills in Dietetic Practice	3
	HNF	375	Community Nutrition	2
	HNF	377	Community Nutrition in Applications	2
	HNF	400	Art and Science of Food Preparation	2
	HNF	406	Sociocultural Aspects of Food	3
	HNF	440	Foodservice Operations	4
	HNF	444	Computerized Foodservice Management Laboratory	2
	HNF	445	Foodservice Management Experience	2
	HNF	453	Nutrition and Human Development	3
	HNF	461	Advanced Human Nutrition: Carbohydrates, Lipids and Proteins	3
	HNF	462	Advanced Human Nutrition: Vitamins and Minerals	3
	HNF	471	Medical Nutrition Therapy I	4
	HNF	472	Medical Nutrtion Therapy II	4
b.	The following courses outside the Department of Food Science and Human Nutrition:			42 to 45
	(1) All of the following courses (30 credits):			
	ANTR	350	Human Gross Anatomy and Structural Biology	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 credits):			
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
	(3) One of the following courses (3 or 5 credits):			
	MTH	103	College Algebra	3
	MTH	116	College Algebra and Trigonometry	5
	(4) One of the following courses (3 or 4 credits):			
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	(5) 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 required courses stress the principles of food preservation and the application of scientific principles to control and enhance the flavor, color, texture, nutritive value, and safety of foods.

In addition to the core program, students in food science must complete one of the following interdisciplinary concentrations that are designed to provide additional breadth and depth: food biotechnology, food business and industry, food chemistry, food packaging, food safety, or food technology.

Food Biotechnology. The food biotechnology concentration is designed for students with an interest in applying an understanding of biotechnology to improving the quantity, quality, and safety of the food supply. Students who complete this concentration may be employed in the food industry or may pursue graduate study in biotechnology, food science, or related areas.

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 Chemistry. This concentration is designed to provide students with a firm foundation for analyzing and understanding the chemical basis for changes in foods which take place during harvest, processing, storage, and consumption. Students who complete this concentration may pursue research and development careers with food companies or government laboratories or may pursue graduate study in food science or related areas.

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 Safety. This concentration allows students to focus on the problems and solutions necessary to enhance the safety of our food supply. Both microbial and chemical food safety issues are addressed. Course work focuses on many topics including chemistry, toxicology, and microbiology as well as the legal aspects of food safety. Students who complete this concentration may hold a variety of positions within the food industry and government or may pursue graduate study in food science or microbiology.

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 325, 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 111, Chemistry 161 and 162, and Physics 231. The completion of Chemistry 161 and 162 satisfies the laboratory requirement. Biological Science 111, 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:			49
	BE	429	Fundamentals of Food Engineering . . . 3	
	BS	111	Cells and Molecules . . . 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	325	Food Processing: Unit Operations . . . 4	
	FSC	401	Food Chemistry . . . 3	
	FSC	402	Food Chemistry Laboratory . . . 1	
	FSC	410	Sensory Assessment of Foods . . . 3	
	FSC	440	Food Microbiology . . . 3	
	FSC	441	Food Microbiology Laboratory . . . 2	
	FSC	455	Food Analysis . . . 3	
	FSC	470	Integrated Approaches to Food Product Development . . . 3	
	HNF	260	Principles of Human Nutrition . . . 3	
	MTH	124	Survey of Calculus I . . . 3	
	PHY	231	Introductory Physics I . . . 3	
b.	*One* of the following six concentrations:			26 to 30

Food Biotechnology (27 or 28 credits):

(1) All of the following courses (21 credits):

BMB	401	Basic Biochemistry . . . 4
CEM	251	Organic Chemistry I . . . 3
CEM	252	Organic Chemistry II . . . 3
CSS	451	Biotechnology Applications for Plant Breeding and Genetics . . . 3
MMG	301	Introductory Microbiology . . . 3
MMG	302	Introductory Laboratory for General and Allied Health Microbiology . . . 1
STT	201	Statistical Methods . . . 4

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

CSS	350	Introduction to Plant Genetics . . . 3
ZOL	341	Fundamental Genetics . . . 4

(3) The following course (3 credits):

HRT	486	Biotechnology in Agriculture: Applications and Ethical Issues . . . 3

Food Business and Industry (27 credits):

(1) All of the following courses (21 credits):

ACC	230	Survey of Accounting Concepts . . . 3
BMB	200	Introduction to Biochemistry . . . 4
CEM	143	Survey of Organic Chemistry . . . 4
MMG	301	Introductory Microbiology . . . 3
MMG	302	Introductory Laboratory for General and Allied Health Microbiology . . . 1
MSC	300	Managerial Marketing . . . 3
STT	315	Introduction to Probability and Statistics for Business . . . 3

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

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
MSC	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 Chemistry (29 credits):
(1) All of the following courses (26 credits):
BMB 401 Basic Biochemistry 4
CEM 251 Organic Chemistry I. . . . 3
CEM 252 Organic Chemistry II 3
CEM 255 Organic Chemistry Laboratory 2
CEM 262 Quantitative Analysis. . . . 3
MMG 301 Introductory Microbiology 3
MMG 302 Introductory Laboratory for General and Allied Health Microbiology. . . . 1
PHY 232 Introductory Physics II. . . . 3
STT 201 Statistical Methods 4
(2) One of the following courses (3 credits):
ANS 407 Food and Animal Toxicology. . . . 3
CEM 333 Instrumental Methods and Applications 3

Food Packaging (30 credits):
(1) All of the following courses:
BMB 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
MMG 301 Introductory Microbiology 3
MMG 302 Introductory Laboratory for General and Allied Health Microbiology. . . . 1
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 Safety (27 credits):
(1) All of the following courses (21 credits):
ANS 407 Food and Animal Toxicology. . . . 3
BMB 200 Introduction to Biochemistry 4
CEM 251 Organic Chemistry I. . . . 3
FSC 421 Food Laws and Regulations 3
MMG 301 Introductory Microbiology 3
MMG 302 Introductory Laboratory for General and Allied Health Microbiology. . . . 1
STT 201 Statistical Methods 4
(2) At least six credits from the following courses:
ANS 417 Topics in Toxicology 1
MMG 425 Microbial Ecology 3
MMG 431 Microbial Genetics. . . . 3
MMG 445 Basic Biotechnology 3
PHM 450 Introduction to Chemical Toxicology. . . . 3

Food Technology (30 credits):
(1) All of the following courses (24 credits):
BMB 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
FSC 410 Sensory Assessment of Foods 3
FSC 420 Quality Assurance 2
FSC 421 Food Laws and Regulations 3
MMG 301 Introductory Microbiology 3
MMG 302 Introductory Laboratory for General and Allied Health Microbiology. . . . 1
STT 201 Statistical Methods 4
(2) Two of the following courses (6 credits):
FSC 430 Food Processing: Fruits and Vegetables 3
FSC 431 Food Processing: Cereals. . . . 3
FSC 432 Food Processing: Dairy Foods 3

SPECIALIZATION IN FOOD PROCESSING AND TECHNOLOGY

The Specialization 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, the Department of Food Science and Human Nutrition in the College of Human Ecology, 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 School. The Department of Food Science and Human Nutrition administers the specialization.

The primary educational objective of the specialization 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 specialization.

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 specialization may also be used to satisfy the requirements for the bachelor's degree.

Requirements for the Specialization in Food Processing and Technology

The student must complete:

			CREDITS
1.	One of the following courses:		3 or 4
	ANS 210	Animal Products 4	
	FSC 211	Principles of Food Science 3	
2.	The following course:		4
	FSC 325	Food Processing: Unit Operations 4	
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.	One of the following courses:		3
	ANS 320	Muscle Foods 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	

Upon completion of the requirements for the Specialization in Food Processing and Technology, the student should contact the Chairperson of the Department of Food Science and Human Nutrition and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Food Science and Human Nutrition and the Director of Academic Affairs of the College of Agriculture and Natural Resources, the Office of the Registrar will enter on the student's academic record the name of the specialization and the date that it was completed. This certification will appear on the student's transcript.

GRADUATE STUDY

The Department of Food Science and Human Nutrition is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science. 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 through the College of Agriculture and Natural Resources. 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 through either the College of Agriculture and Natural Resources or the College of Natural Science. 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, pathology, genetics, psychology, or sociology. Students in this program must meet the requirements of the university and of the College of Agriculture and Natural Resources and the College of Natural Science.

Doctor of Philosophy

Students in the Doctor of Philosophy degree in Human Nutrition may specialize in biochemical nutrition or in community nutrition. Course and research programs are designed to develop the student's scholarly potential. Major emphasis is placed upon the completion by the student of original research which should provide a significant contribution to knowledge.

Students in this program must meet the requirements of the university and of the College of Agriculture and Natural Resources and the College of Natural Science.

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

Daniel E. Keathley, Chairperson

UNDERGRADUATE PROGRAMS

The Department of Forestry offers programs of instruction in forest resource management, urban and community forestry, wood products manufacturing and marketing, forest conservation and environmental studies, and forest sciences, all leading to the Bachelor of Science degree with a major in Forestry. Michigan State University's undergraduate forestry program is the oldest existing undergraduate forestry program in the United States. The forest resource management curriculum is accredited as a professional forestry program by the Society of American Foresters.

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

FORESTRY

Forest ecosystems, which comprise about one-third of the land area of the United States, are an extremely valuable resource that benefit society in many ways. They provide the renewable resource base for essential forest products, forage, and wildlife habitat. Forests stabilize stream flow, reducing soil erosion, floods, and avalanches, and are important in the regulation of air temperature in urban and rural settings. Forests also play a critical role in maintaining a proper carbon dioxide balance in the earth's atmosphere and are valued for their aesthetic enrichment of our lives and for the widespread opportunities for outdoor recreation they provide.

Forestry is the science and art of managing the natural resources that occur on and in association with forested lands in both the urban and rural landscape. These resources include trees, other plants, animals, soil, minerals, and climate and related air and water. The practice of forestry means management for specific objectives, whether timber production, recreational opportunities, wildlife habitat, forage, water regulation, preservation for scientific studies and special uses, or combinations of these uses.

Foresters are employed in a variety of settings. Many choose careers with industry, working for large multinational forest products companies or for smaller producers of forest products. Others work for public land management agencies, such as the U.S. Forest Service, National Park Service, Fish and Wildlife Service, Soil Conservation Service, or state departments of natural resources. Conservation organizations, such as the Wilderness Society or Sierra Club, have foresters on their staffs. Foresters with an international interest work for the Peace Corps or other international organizations. Still others find rewarding careers with municipal forestry organizations or with private tree and shrub-care companies. Finally, many foresters pursue additional education and careers in science: ecology, forest genetics, wood science, soils science, biometry, economics, and many others.

Students in this major must meet the requirements for one of the following five concentrations: Forest Resource Management, Urban and Community Forestry, Wood Products Manufacturing and Marketing, Forest Conservation and Environmental Studies, or Forest Sciences.

Forest Resource Management. Around the world, unprotected and unmanaged forests are being depleted and destroyed. Management is required to sustain our forests, and Michigan State University's forest management concentration provides the in-depth understanding of natural and social sciences necessary to manage forest ecosystems. Through hands-on laboratory experiences and field studies, students develop the ability to manage forests for goals ranging from providing biological diversity to producing timber and creating desired wildlife habitat. Students who elect the forest resource management concentration acquire the skills necessary to evaluate and take action to ensure the ecological, economic, and social sustainability of forests. They find employment with public land management agencies, private organizations, the forest products industry, consulting firms, and trade associations. This concentration is fully accredited by the Society of American Foresters (SAF). Students who complete the Bachelor of Science degree in Forestry with this concentration are eligible for full membership in the SAF.

Urban and Community Forestry. The urban and community forestry concentration focuses on the forests in communities where people live. This concentration has courses that provide an understanding of the biological aspects of urban forestry and the care and maintenance of individual trees, focus on understanding the dynamics of working with people and communities, and prepare graduates to develop, manage, and work in urban tree care companies. Students will be prepared to work in the tree-care industry, as municipal foresters, or in other positions with public agencies and community groups.

Wood Products Manufacturing and Marketing. The forest product industry is in need of people who understand the business of wood products. Professionals in forest products are well paid and are in high demand. Students who elect this concentration will find employment in manufacturing, marketing, management, technical service and research. Employment in this area requires high-level skills in management and marketing, a broad technical background in processing operations, and a fundamental understanding of wood properties. This concentration is multi-disciplinary and offers knowledge of fundamental wood science and technology including the biological, chemical, physical, and mechanical properties of wood, and processing operations including wood gluing, wood preservation, and wood modification. Study of manufacturing processes and engineered wood composites prepares graduates to become leaders in the forest products industries.

Forest Conservation and Environmental Studies. This concentration focuses on conservation and forest ecology and technical aspects of forest management. Students receive a strong scientific preparation for understanding natural resource issues. This concentration emphasizes the development of analytical and communications skills necessary to create a positive interchange of ideas between forestry professionals and non-technical audiences. Students in this concentration gain an understanding of forest systems and forest dynamics, a well as human interactions with the environment, and our ability to sustain, enhance, rehabilitate, and conserve forests. Basic scientific training in chemistry, physics, biology, and ecology and specialized courses in forest biology, soils, and conservation are required. Additional course work in natural resource economics and social science, natural resource law, environmental communication, international forestry, and a range of electives allow students to develop their interests in alignment with personal career goals. The professional skills developed through the Forest Conservation and Environmental Studies concentration will enable graduates to make significant contributions to resolving preservation and use issues.

Forest Science. The forest science concentration is designed for students electing scientific study of a discipline of forestry. Disciplines may include biometry, botany, ecology, economics, entomology, genetics, hydrology, management science, forest physiology, silviculture, social science, soil science, or wood science. The forest science concentration is intended primarily for students planning to pursue science careers, obtain graduate degrees, and work in education, industry or institutional research positions. For admission as a junior to the forest science concentration, students must have a minimum cumulative grade-point average of 3.25. To apply, students must meet with a Department of Forestry faculty advisor to prepare a program of 18 credits that is approved by the student's advisor, the Undergraduate Curriculum Committee, and the department chairperson.

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 464. That course is 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:
   a. Biological Science 110, or Plant Biology 105 and 106 combined.
   b. Chemistry 141, 143, and 161.

   The completion of Chemistry 161 and either Biological Science 110 or Plant Biology 106 satisfies the laboratory requirement. Biological Science 110, or Plant Biology 105 and 106 combined, 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 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 116, 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 143	Survey of Organic Chemistry	4
	CEM 161	Chemistry Laboratory I	1
	COM 100	Human Communication	3
	CSS 210	Fundamentals of Soil Science	3
	EC 202	Introduction to Macroeconomics	3
	FOR 202	Introduction to Forestry	3
	FOR 204	Forest Vegetation	4
	FOR 304	Wood Technology	4
	FOR 306	Forest Biometry	4
	FOR 330	Social Applications in Forestry	2
	FOR 404	Forest and Agricultural Ecology	3
	FOR 404L	Forest and Agricultural Ecology Laboratory	1
	FOR 406	Silviculture	4
	FOR 420	Forestry Field Studies	3
	FOR 464	Forest Resource Economics (W)	3
	GEO 221	Introduction to Geographic Information	3
	MTH 116	College Algebra and Trigonometry	5
	PLB 105	Plant Biology	3
	PLB 106	Plant Biology Laboratory	1
b.	One of the following five concentrations:		23 to 28
	Forest Resource Management (23 credits):		
	(1) All of the following courses (17 credits):		
	FOR 400	Forest Harvest Operations	2
	FOR 408	Forest Resource Management	3
	FOR 412	Wildland Fire	2
	FOR 466	Natural Resource Policy	3
	PLP 407	Diseases and Insects of Forest and Shade Trees	4
	PLS 313	Public Policy Analysis	3
	(2) One of the following courses (3 credits):		
	PRR 448	Foundations of Natural Resource Based Recreation	3
	PRR 449	Natural Resource Based Recreation Management Applications	3
	(3) One of the following courses (3 credits):		
	FW 410	Upland Ecosystem Management	3
	FW 444	Conservation Biology	3
	Forest Conservation and Environmental Studies (23 to 27 credits)		
	(1) All of the following courses (12 credits):		

FOR 466 Natural Resource Policy 3
FW 444 Conservation Biology 3
HST 391 Environmental History of North America 3
PRR 302 Environmental Attitudes and Concepts 3

(2) One of the following courses (3 or 4 credits):
FW 443 Restoration Ecology 3
PLP 407 Diseases and Insects of Forest and Shade Trees 4
ENT 422 Aquatic Entomology 3
ENT 477 Pest Management. I: Pesticides in Management Systems. 3

(3) One of the following courses (2 to 4 credits):
FOR 412 Wildland Fire 2
GLG 201 The Dynamic Earth 4
GLG 302 Geology of Michigan 3
MMG 426 Biogeochemistry 3

(4) One of the following courses (3 credits):
PLS 310 Public Bureaucracy in the Policy Process 3
PLS 313 Public Policy Analysis 3
PLS 331 Political Parties and Interest Groups. 3
ZOL 446 Environmental Issues and Public Policy 3

(5) One of the following groups, either (a) or (b) (3 or 4 credits):
(a) SOC 452 Environment and Society 3
SOC 452L Internship in Environment and Society . 1
(b) NSC 192 Environmental Issues Seminar 1
NSC 292 Applications in Environmental Studies . 2

Forest Sciences (28 credits)

(1) All of the following courses (8 credits)
FOR 308 Forest Science Research Seminar 2
FOR 410 Forest Conservation Thesis (W) 3
STT 464 Strategies for Biologists 3

(2) One of the following courses (3 credits):
MTH 124 Survey of Calculus I 3
MTH 132 Calculus I 3

(3) Complete an additional 17 credits of courses approved by the advisor, Undergraduate committee and chairperson.

Wood Products Manufacturing and Marketing (23 credits)

All of the following courses (23 credits)
ADV 205 Principles of Advertising 4
CMP 124 Residential Construction Materials and Methods . . . 3
FOR 305 Wood Composites. 2
FOR 307 Lumber Manufacturing and Processing 3
FOR 393 Forest Products Internship 2
FOR 415 Forest Products Marketing 2
GBL 323 Introduction to Business Law 3
STT 421 Statistics I 3

Urban and Community Forestry (27 credits)

(1) All of the following courses (24 credits)
ADV 260 Principles of Public Relations 4
FOR 460 Arboriculture 3
FOR 461 Urban Forestry 3
FOR 466 Natural Resource Policy 3
HRT 311 Landscape Design and Management Specifications 4
PLP 407 Diseases and Insects of Forest and Shade Trees 4
PLS 313 Public Policy Analysis 3

(2) One of the following courses (3 credits):
SOC 361 Contemporary Communities 3
SOC 375 Urban Sociology 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.

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.

A joint degree program in forest business management leading to the Master of Science degree in Forestry and the Master of Business Administration degree is also offered in cooperation with The Eli Broad Graduate School of Management. The joint degree program usually requires two years of study, the first in the Department of Forestry and the second in the Broad School.

The Department of Forestry is affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in the Department of Forestry, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior in the *College of Natural Science* section of this catalog.

Students who are enrolled in Master of Science degree programs in the Department of Forestry may elect a Specialization in Ecology, Evolutionary Biology and Behavior. For additional information, refer to the statement on the specialization in the *College of Natural Science* section of this catalog.

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 academic 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 three academic years. 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.

DEPARTMENT of HORTICULTURE

Randolph M. Beaudry, Acting Chairperson

The subject of horticulture was first taught at the Agricultural College of the State of Michigan in a combined Department of Botany and Horticulture in 1858. The Department of Horticulture at Michigan State University, the first such department at an institution in the United States, began as an independent department with its first chairperson, Liberty Hyde Bailey in 1883. The department is administered by the College of Agriculture and Natural Resources.

Horticulture is a complex and integrative discipline encompassing the biological, physical, and management sciences and the arts to improve plant production and management, enhance human health, provide personal enrichment, and improve the environment. Horticulture includes floriculture, landscape horticulture, olericulture (vegetables), pomology (fruits), and other plant species. Horticultural crops and their uses connect agricultural producers, consumers, society, and the environment. With over 130 majors in our four-year program and nearly 100 students in our two-year Institute for Agricultural Technology, we have one of the largest undergraduate horticulture programs in the US. We offer two areas of concentration for our four-year students: horticultural science and landscape design, construction and management. Additionally, two on-campus certificate program administered by the Institute of Agricultural Technology are offered in landscape and nursery management, and organic farming. A landscape and lawn management certificate program is offered in conjunction with Grand Rapids Community College and a landscape and nursery certificate program is offered with Northwestern Michigan College. All of our programs require an internship experience. Our undergraduate curriculum is continuously reviewed and evaluated for opportunities to introduce new concepts, practices, and technologies, and to ensure that the curriculum is well-integrated with practical and hands-on experiences and internships to help students develop problem solving skills in management, design, science, and technology.

Students will have opportunities to enroll in courses online, courses which are integrated with outreach/extension programs (on and off campus) and 1- and 2-credit-module courses offered in 5- and 10- week periods. Students are extensively involved in professional and social activities beyond the classroom: working in research laboratories; assisting in landscape, greenhouse, garden, and nursery operations; running the Horticulture Club's very popular annual spring garden show; and participating in academic and field events associated with the Professional Landcare Network (PLANET) and the Mid-American Collegiate Horticultural Society.

Our classrooms, computer access, and laboratory facilities are housed in a state-of-the-art Plant and Soil Sciences Building. Other facilities include the award-winning Horticultural Demonstration Gardens, the nationally recognized 4-H Children's Gardens, the Lewis Arboretum and the Horticulture Teaching and Research Center (HTRC) on south campus. Our newly established student organic farm is located at the HTRC where ten acres are devoted to a Community Supported Ag (CSA) farm for students to gain practical experience and produce food for CSA members.

UNDERGRADUATE PROGRAM

Horticulture is the science and art concerned with the culture, marketing, and utilization of high–value intensively cultivated plants. Horticultural crops are diverse, including both annual and perennial species, both food and ornamental plants, and plants grown both 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 academic study of horticulture is by its nature highly integrative. The undergraduate program combines scientific knowledge, knowledge of technology, and problem–solving skills for application in various professions related to horticulture. Students in horticulture study such diverse fundamental disciplines as physical science (chemistry), biological sciences (botany, genetics, plant physiology, entomology, and plant pathology), environmental science (soil science), and business (economics, management, and marketing). Communication and computer skills are also cultivated within the horticulture curriculum. Students complete either the Horticultural Science concentration or the Horticulture Landscape Design, Construction, and Management concentration. In both concentrations, students obtain hands–on experiences through laboratory exercises in the greenhouses, in the horticulture gardens, or at the Horticulture Teaching and Research Center. 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 addi-

tional 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 I	2
	HRT 203L	Principles of Horticulture I Laboratory	1
	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 two concentrations:		33 or 42

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) Twelve credits of designated production course work from an approved departmental list.

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

HRT	401	Physiology and Management of Herbaceous Plants	3
HRT	480	Woody Plant Physiology	3

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

CSS	451	Biotechnology Applications for Plant Breeding and Genetics	3
HRT	401	Physiology and Management of Herbaceous Plants	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 (42 credits):

(1) All of the following courses:

ATM	431	Irrigation, Drainage and Erosion Control Systems	3
CSS	232	Introduction to Turfgrass Management	3
HRT	210	Nursery Management	3
HRT	211	Landscape Plants I	3
HRT	212	Landscape Plants II	3
HRT	311	Landscape Design and Management Specifications	4
HRT	411	Landscape Contract Management	3
HRT	480	Woody Plant Physiology	3
LA	220	Graphic Communication	4
LA	330	Site Construction: Materials and Methods	4
MTH	116	College Algebra and Trigonometry	5
PLP	407	Diseases and Insects of Forest and Shade Trees	4

GRADUATE STUDY

The Department of Horticulture offers graduate study leading to the Master of Science and Doctor of Philosophy degrees. Areas of study include: floriculture, landscape horticulture, pomology, and vegetable crops, with several areas of specialization according to the student's research interest.

The Department of Horticulture is affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in the Department of Horticulture, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior in the *College of Natural Science* section of this catalog.

Students who are enrolled in Master of Science degree programs in the Department of Horticulture may elect a Specialization in Ecology, Evolutionary Biology and Behavior. For additional information, refer to the statement on the specialization in the *College of Natural Science* section of this catalog.

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 Selke, Acting 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 a cognate in business to prepare students for rewarding careers in the manufactured products industries. 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. Elective courses provide for broad, general preparation or for focused study in food packaging, medical packaging, pharmaceutical packaging, automotive packaging, distribution, robotics, and other areas.

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 116.
   c. Physics 231.

The student's cumulative grade–point average for all courses completed is considered in the admission decision. 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 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 315 and 485. Those courses are referenced in item 3. a. 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; Biological Science 110 or 111; or Food Science 342 or Microbiology 201. The completion of Chemistry 143 and 161 satisfies the laboratory requirement. Chemistry 141, 143 and 161; Food Science 342 or Microbiology 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. The completion of Mathematics 116 satisfies the College's mathematics requirement.
3. The following requirements for the major:

				CREDITS
a.	All of the following courses:			51
	ACC	230	Survey of Accounting Concepts . . . 3	
	CEM	141	General Chemistry . . . 4	
	CEM	143	Survey of Organic Chemistry . . . 4	
	CEM	161	Chemistry Laboratory I . . . 1	
	MTH	116	College Algebra and Trigonometry . . . 5	
	PKG	101	Principles of Packaging . . . 3	
	PKG	221	Packaging with Glass and Metal . . . 3	
	PKG	315	Packaging Decision Systems (W) . . . 3	
	PKG	322	Packaging with Paper and Paperboard . . . 4	
	PKG	323	Packaging with Plastics . . . 4	
	PKG	410	Distribution Packaging Dynamics . . . 3	
	PKG	432	Packaging Processes . . . 4	
	PKG	485	Packaging Development (W) . . . 4	
	PHY	231	Introductory Physics I . . . 3	
	PHY	232	Introductory Physics II . . . 3	
b.	One of the following courses:			3 or 4
	BS	110	Organisms and Populations . . . 4	
	BS	111	Cells and Molecules . . . 3	
	FSC	342	Food Safety and Hazard Analysis Critical Control Point Program . . . 3	
	MMG	201	Fundamentals of Microbiology . . . 3	
c.	One of the following courses:			3
	MTH	124	Survey of Calculus I . . . 3	
	MTH	132	Calculus I . . . 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.	Three of the following courses:			10 to 12
	ADV	205	Principles of Advertising . . . 4	
	FI	320	Introduction to Finance . . . 3	
	GBL	323	Introduction to Business Law . . . 3	
	MGT	325	Management Skills and Processes . . . 3	
	MSC	303	Introduction to Supply Chain Management . . . 3	
	MSC	327	Introduction to Marketing . . . 3	

f. Six additional credits in Packaging courses *excluding* Packaging 490 and 492. Three credits in a packaging internship completed under Packaging 493 or in a packaging overseas study program may be counted toward this requirement. 6

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 in the following areas: 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, and mechanical properties of packaging materials and systems. Other areas of study include 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 specialization in one of the areas 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.

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 a total of 16 credits in Packaging courses at the 400-level or above including:
   a. Packaging 827.
   b. Packaging 805 or 815.
2. Demonstrate an understanding of basic statistics.

Additional Requirements for Plan A

1. An additional 3 credits in 800-900 level Packaging courses excluding Packaging 888, 890, and 899.
2. At least six, but not more than eight, credits of Packaging 899.

Additional Requirements for Plan B

1. An additional 6 credits in 800-900 level Packaging courses excluding Packaging 888, 890, and 899.
2. Two credits of Packaging 888.

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:

	CREDITS
1. Complete both of the following courses:	
PKG 985 Analytical Solutions to Packaging Design	3
PKG 992 Packaging Seminar	2
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, mass transport applications, or the dynamics and physical distribution aspects of packaging.	

SCHOOL of PLANNING, DESIGN and CONSTRUCTION

Scott G. Witter, 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, land-

scape 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 world-grant 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 multi-disciplinary 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.

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 with a cumulative University grade-point average of at least 2.30.
2. Completion of the following courses with a minimum grade-point average of 2.00:

a.	MTH	124	Survey of Calculus I	3
b.	PHY	231	Introductory Physics I. . . .	3
c.	STT	200	Statistical Methods	3
	or			
	STT	201	Statistical Methods	4
	or			
	STT	315	Introduction to Probability and Statistics for Business	3
	or			
	STT	421	Statistics I	3
d.	EC	201	Introduction to Microeconomics	3
	or			
	EC	202	Introduction to Macroeconomics	3

While a cumulative university grade-point average of 2.30 is necessary to be considered for admission to the school, it does not guarantee admission. Admission decisions are based primarily on cumulative University grade-point average and grades in the courses listed above. Other factors such as work experience, personal experience, performance in construction management courses, 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 110 *or* Biological Science 111 and 111L *or* Plant Biology 105 and 106 *or* Microbiology and Molecular Genetics 205 and 206. The completion of Physics 251 *and* Biological Science 110 *or* 111L *or* Plant Biology 106 *or* Microbiology and Molecular Genetics 206 satisfies the laboratory requirement. With advisor approval, for this laboratory requirement, Biological Science 111L, 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 110 or 111 and 111L 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:.			70
	ACC	230	Survey of Accounting Concepts	3
	CMP	101	Principles of Building 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
	CMP	305	Site Construction and Measurement.	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	2
	CMP	353	Land Development	3
	CMP	385	Construction Documents and Contracts (W)	3
	CMP	401	Construction Safety Management	3
	CMP	411	Construction Project Scheduling	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.			
b.	One of the following courses:			3
	CMP	435	Residential Building Projects (W)	3
	CMP	436	Commercial Building Projects (W)	3
	CMP	493	Professional Internship in Building Construction Management	3
c.	Complete four credits from the following courses:			4
	CEM	141	General Chemistry	4
	CEM	161	Chemistry Laboratory I	1
	FOR	419	Applications of Geographic Information Systems to Natural Resource Management	4
	PHY	232	Introductory Physics II	3
	PHY	252	Introductory Physics Laboratory II	1
d.	Complete one of the following courses:			3 or 4
	ADV	160	Media Relations for Professionals	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
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
	STT	421	Statistics I	3
f.	One of the following courses:			3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
g.	One of the following courses:			3
	FI	320	Introduction to Finance	3
	MSC	303	Introduction to Supply Chain Management	3
	MSC	327	Introduction to Marketing	3
h.	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 Foundation for Interior Design Education Research (F.I.D.E.R.).

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 Undergraduate University Division 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 selected interior design courses.

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. 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
	HED	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.			
c.	One of the following courses:			5
	MTH	110	Finite Mathematics and Elements of College Algebra	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 **two** of the following History of Art courses (6 to 8 credits):			
	HA	120	Perspectives on World Art: What is Art?	4
	HA	209	Ancient Art	3
	HA	210	Medieval Art	3
	HA	220	Renaissance Art	3
	HA	232	Baroque and Rococo Art	3
	HA	250	American Art	3

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 American Society of Landscape Architects.

Upon completion of the undergraduate program, the individual is prepared to participate at the entry level of professional landscape architecture or to pursue graduate study leading to more specialized phases of professional work.

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.

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 Director for Landscape Architecture, School of Planning, Design and Construction.

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; 139 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: Biological Science 110, Chemistry 141 and 161, and Zoology 355 and 355L. The completion of Chemistry 161 and Zoology 355L satisfies the laboratory requirement. Biological Science 110, Chemistry 141 and 161, and Zoology 355 and 355L 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 or 492. Those courses are referenced in item 2. d. below.
2. The following requirements for the major:

				CREDITS
a.	A minimum grade–point average of 2.00 in the 43 credits required in 300–400 level Landscape Architecture courses referenced in requirement 2.d. below.			
b.	Collateral Courses:			31
	(1) All of the following courses (28 credits):			
	BS	110	Organisms and Populations	4
	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
	MTH	116	College Algebra and Trigonometry[1]	5
	UP	494	Planning Practicum	4
	(2) One of the following courses (3 credits):			
	GEO	221	Introduction to Geographic Information	3
	IDES	240	Computer Aided Design for Designers	3
c.	Environmental Cognate Courses:			16
	(1) All of the following courses (10 credits):			
	CSS	210	Fundamentals of Soil and Landscape Science[1]	3
	GEO	206	Physical Geography	3
	ZOL	355	Ecology	3
	ZOL	355L	Ecology Laboratory	1
	(2) At least 6 additional credits in courses related to the environment approved by the student's academic advisor.			
d.	Landscape Architecture Courses: All of the following courses:			57
	LA	200	Introduction to Landscape Architecture[1]	3
	LA	220	Graphic Communication[1]	4
	LA	240	Applied Design Fundamentals[1]	4
	LA	270	Landscape Design History[1]	3
	LA	330	Site Construction: Materials and Methods	4
	LA	331	Site Engineering	4
	LA	341	Basic Site Design I	4
	LA	342	Basic Site Design II	5
	LA	437	Design Implementation	3
	LA	443	Community Project Design I	5
	LA	444	Community Project Design II	5
	LA	445	Advanced Project Design	4
	LA	446	Regional Environmental Design	3
	LA	480	Professional Practice (W)	3
	LA	492	Senior Research Seminar (W)	3
e.	One of the following courses:			3
	EC	201	Introduction to Microeconomics	3
	EC	202	Introduction to Macroeconomics	3
f.	Directed Electives: A minimum of 12 additional credits in courses in the College of Arts and Letters and/or the College of Social Science 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.			12

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

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, Interior Design, and Urban and Regional Planning. The School offers programs leading to graduate degrees in the following fields:

Master of Arts
Environmental Design
Interior Design and Facilities Management
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
Construction Management

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 3.00 (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:

	CREDITS
Requirements for Plan A	
1. A minimum of 18 credits in 800–900 level courses.	
2. All of the following courses:	
CMP 817 Construction 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.

Doctor of Philosophy

Advances in modern construction technologies and methods underscore the need for sound and rigorous management of construction processes, organizational structures, business models, and the capability of integrating technology and management to create value for the user. The Doctor of Philosophy in Construction Management will provide students with the ability to conduct research on construction management including management theories and their applications in various sectors of the construction industry and to serve as professionals in the field of construction management.

Students in the program will have opportunities to study topics including: construction project management, construction technology, lean construction, sustainable built environment, international project management, and facilities management.

Admission

To be considered for admission to the Doctor of Philosophy degree program in Construction Management, an applicant must submit scores on the Graduate Record Examination (GRE) General Test or the Graduate Management Admission Test (GMAT).

To be admitted to the Doctor of Philosophy degree program in Construction Management on regular status, a student must have:

1. completed a master's degree program in a related field.
2. acceptable scores on the GRE General Test or the GMAT.

Provisional admission may be granted to an applicant who does not meet the above requirements but demonstrates outstanding potential.

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 doctoral focus area within the School, a third member should be from another doctoral focus area within the School, and a fourth member from outside the School.

Requirements for the Doctor of Philosophy Degree in Construction Management

	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 construction management as specified by the student's guidance committee.	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 construction management.	

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 (9 credits):	
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: Horticulture; or Community, Agriculture, Recreation and Resource Studies. They must also prepare a written thesis, complete a final research seminar, and pass an oral examination.

For **Plan B**, students must complete a minimum of 6 and a maximum of 9 credits of Master's Research (898) in the department of Horticulture. They must also complete a final report and pass an oral examination.

INTERIOR DESIGN AND FACILITIES MANAGEMENT

Master of Arts

The program is designed to provide students with advanced knowledge in one of three major areas of specialization: facilities design and management, human shelter, and interior design preservation and conservation. Internships are available.

Admission

Students must have undergraduate preparation and competencies in the areas of interior design, architecture, business, history, housing, or other areas as appropriate to their chosen specialty within the M.A. degree program.

Requirements for the Degree

Students must complete required core courses, the requirements for one of the major areas of concentration referenced above, a required research component, and the requirements for a minor area.

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.

The Department of Plant Biology is affiliated with the Doctor of Philosophy degree program with a major in ecology, evolutionary biology and behavior. For information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in the Department of Plant Biology, refer to the statement on the doctoral program in ecology, evolutionary biology and behavior in the *College of Natural Science* section of this catalog.

Students who are enrolled in Master of Science degree programs in the Department of Plant Biology may elect a Specialization in Ecology, Evolutionary Biology and Behavior. For additional information, refer to the statement on the Specialization in Ecology, Evolutionary Biology and Behavior 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.*

DEPARTMENT OF PLANT PATHOLOGY

Raymond Hammerschmidt, Chairperson

The Department of Plant Pathology is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science.

Plant pathology is concerned with fundamental relationships involving the diseased plant. This includes study of the interaction between the plant, its environment, and, in most instances, a microorganism or virus. Ecological, morphological, biochemical, and physiological aspects of plant disease development are studied in relation to the more specialized fields of molecular biology, cellular biology, virology, bacteriology, mycology, genetics, and others. Plant pathological research also contributes to fundamental biology, as well as to practical plant disease control.

UNDERGRADUATE PROGRAM

The Department of Plant Pathology offers a Bachelor of Science degree in Plant Pathology. Earning a Bachelor of Science degree in Plant Pathology will prepare graduates for careers in agricultural industries, government programs (state, national and international), as well as for graduate study in plant pathology and numerous other fields in agriculture and natural science. The Bachelor of Science in Plant Pathology major enables students to take a substantial number of fundamental sciences courses as well as a large number of more applied courses related to plant diseases and agriculture. Course work in this vigorous curriculum offers a balance between fundamental and applied study. Those students who take a large number of fundamental courses may choose to attend graduate school. The actual numbers of fundamental versus applied courses that qualify a student for career or graduate opportunities vary greatly.

Requirements for the Bachelor of Science Degree in Plant Pathology

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 Plant Pathology.

   The University's Tier II writing requirement for the Plant Pathology major is met by completing Plant Pathology 405 and 498.

   Students who are enrolled in the Plant Pathology major leading to Bachelor of Science degree may complete the alternative track to Integrative Studies in Biological and Physical Sciences that consists of the following courses: Chemistry 141, 143, and 161 and Plant Biology 105 and 106. The completion of Chemistry 141, 143, 161 and Plant Biology 105 and 106 may be counted towards 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 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:			48 or 50
	CEM	141	General Chemistry	4
	CEM	143	Survey of Organic Chemistry	4
		or		
	CEM	251	Organic Chemistry I	3
	CEM	161	Chemistry Laboratory I	1
	CEM	252	Organic Chemistry II	3
	CSS	350	Introduction to Plant Genetics	3
	MMG	301	Introductory Microbiology	3
	MTH	124	Survey of Calculus I	3
		or		
	STT	201	Statistical Methods	4
	PHY	231	Introductory Physics I	3
	PLB	105	Plant Biology	3
	PLB	106	Plant Biology Laboratory	1
	PLB	301	Introductory Plant Physiology	3

	PLB	402	Biology Fungi	3
	PLP	101	Current Issues and Frontiers in Plant Pathology	1
	PLP	405	Introductory Plant Pathology	3
	PLP	407	Diseases and Insects of Forest and Shade Trees	4
	PLP	492	Seminar	2
	PLP	493	Plant Pathology Internship	3
	PLP	498	Undergraduate Research	3
b.	One of the following courses or pair of courses (3 credits):			
	CSS	101	Introduction to Crop Science	3
	FOR	202	Introduction to Forestry	3
	HRT	203	Principles of Horticulture I	2
	and			
	HRT	203L	Principles of Horticulture I Laboratory	1
c.	One of the following courses (3 or 4 credits):			
	CSS	210	Fundamentals of Soil and Landscape Science	3
	CSS	402	Principles of Weed Science	3
	ENT	404	Insects: Success in Biodiversity	4
	ZOL	355	Ecology	3
d.	One of the following courses (4 credits):			
	CSS	451	Cellular and Molecular Principles and Techniques for Plant Sciences	4
	PLB	416	Experiments in Plant Physiology and Molecular Biology	4
e.	One of the following courses (3 or 4 credits):			
	ENT	470	General Nematology (W)	3
	ENT	478	Pest Management II: Biological Components of Management Systems (W)	3
	PLP	362	Management of Turfgrass Pests	4
f.	One of the following courses or pair of courses (3 to 6 credits):			
	BMB	401	Basic Biochemistry	4
	BMB	461	Biochemistry I	3
	and			
	BMB	462	Biochemistry II	3
	CEM	142	General and Inorganic Chemistry	3

Students desiring to study plant pathology may also emphasize fundamental science, biotechnology, plant protection, or agribusiness management, and modify their programs accordingly with approval of their academic advisor and the department chairperson.

It is required that a grade point average of 2.0 be obtained in major courses (Plant Pathology 101, 405, 407, 492, 493, and 498) in order for a B.S. Degree in Plant Pathology to be awarded. Students who take Biochemistry and Molecular Biology 401, 461 and 462, and Crop and Soil Sciences 451 in addition to Plant Pathology major requirements, may also take Horticulture 486 to complete the College of Agriculture and Natural Resources requirements for the Specialization in Agricultural and Natural Resources Biotechnology.

GRADUATE STUDY

The department offers Master of Science and Doctor of Philosophy degree programs with a major in plant pathology. Students enrolled in the Doctor of Philosophy degree program may elect a Specialization in Biotechnology. For additional information, refer to the statement on the specialization.

Students who are enrolled in Master of Science degree programs in the Department of Plant Pathology 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.

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.

INSTITUTE of AGRICULTURAL TECHNOLOGY

Eunice F. Foster, Director

Founded in 1894, the Institute of Agricultural Technology delivers innovative, educational programs 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. Certificate programs vary from 10 to 24 months in length, are highly respected statewide and nationally, and several have international reputations. Classes 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, 120 Agricultural Hall, East Lansing, MI 48824-1039.

PROGRAMS

Agricultural Industries

One of every six jobs in the American economy is related to agricultural and food businesses. The curriculum in the Agricultural Industries program is designed to provide students with the technical and business skills necessary to be successful in any of these related fields. Career opportunities range from managing a farm or business (cash crop, animal, or fruit/vegetable) to working in the banking or farm credit industries. Ample opportunities are available in the management of farm supply stores or cooperatives, in agricultural input sales, in the insurance field, or in a number of agricultural processing and manufacturing industries.

The Agricultural Industries program allows students to customize their educational program to fit their own personal career goals. This program has two main areas of study – agronomy and business. However, the student who has an interest in the animal industry may obtain foundational knowledge in the species of his/her choice.

Attractive starting salaries are offered. Advancement opportunities are excellent for those who prove themselves on the job. Initiative and ability determine how fast progress can be made towards a management position.

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) and Michigan State University offer a combined program, which enables students to complete an NMC Associate of Applied Science degree as well as an MSU Institute of Agricultural Technology certificate - without leaving northern Michigan.

Bringing together the world-acclaimed expertise of Michigan State University's College of Agriculture and Natural Resources and the "close to home" convenience of an outstanding community college - Northwestern Michigan College in Traverse City – 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 options in Commercial Horticulture Operations or Commercial Turfgrass Operations.

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

				CREDITS
The student must complete 35 credits from the following:				
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	205	Reproduction in Livestock	2
	ANS	215	Growth, Health and Lactation in Dairy Cattle	2
	ANS	222	Introductory Beef Cattle Management	3
	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
AT	045	Agricultural Communications	2
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 16 credits of elective course work from the following:

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	Agricultural Industry Issues	3
CSS	201	Forage Crops	3
CSS	212	Advanced Crop Production	2

Electrical Technology

There is a need for highly trained electricians. Electrical contractors need electricians capable of planning complex wiring and solving difficult wiring problems. Wiring systems today are complex. In some cases, equipment breakdowns must be repaired promptly to avoid devastating losses.

The Electrical Technology program is a complete electrical apprenticeship program recognized by the State Electrical Administrative Board. Graduates of the program receive credit for two years of experience by completing only 15 months of training. Four years of experience are required for the State Journeyman Electrician License Exam.

The program covers residential, farm, commercial, and industrial wiring; single and three phase motors and generators; electrical control systems wiring, design and troubleshooting; lighting system design; electrical system design; heating; animal and human environment control; electrical estimating; and electrical business management.

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

The current demand for landscape horticulturalists is due to the rapid expansion in industrial and home landscapes as well as city, state, and environmental improvement projects. Graduates of the landscape and nursery program work as owners, managers, buyers, or salespersons in retail firms, commercial landscape construction, and nursery production firms 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 nursery, other important aspects of a college education are included. Students are required to take courses in fields such as communications, botany, biochemistry, soil science, plant diseases, and personnel practices.

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

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 18 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.

Organic Farming

Organic farming is one of the fastest growing and expanding areas of agriculture. There are viable business opportunities for small-scale producers to meet the consumer demand for fresh, local vegetables, fruits and herbs by marketing at the growing number of farmer's markets, community supported agriculture (CSA) farms, as well as other direct and wholesale markets. This program is a 12-month (January to December) introduction to intensive and year-round organic farming. The organic farming program consists of course work, the operation of a diversified small-scale organic farm on the Michigan State University campus, and a 16-week placement training or apprenticeship on a

working farm or with a community or urban garden project. Emphasis is on the production of vegetables, fruit, herbs, and cut flowers with CSA and farm stand marketing. Winter production occurs in unheated and heated greenhouses. The curriculum includes how to build and maintain soil quality and fertility primarily with on-farm resources and farming methods that cultivate a diverse, profitable and resilient farm. No previous farming experience is required. This program is especially suitable for applicants seeking a new direction and employment related to organic farming and gardening, community and urban garden projects, and other food system and environmental careers.

Requirements for Organic Farming

				CREDITS
1.	All of the following courses (26 credits):			
	AT	045	Agricultural Communications	2
	AT	071	Technical Mathematics	2
	HRT	242	Passive Solar Greenhouses for Protected Cultivation	1
	HRT	243	Organic Transplant Production	1
	HRT	251	Organic Farming Principles and Practices	3
	HRT	252	Organic Certification and Farm Plans	1
	HRT	253	Compost Production and Use	1
	HRT	256	Organic Produce Direct Marketing	1
	HRT	257	Organic Produce Wholesale Marketing	1
	HRT	258	Study a Farm	3
	HRT	259A	Student Organic Farm Practicum I	3
	HRT	259B	Student Organic Farm Practicum II	4
	HRT	259C	Student Organic Farm Practicum III	3
2.	One of the following courses (2 or 3 credits):			
	HRT	109	Introduction to Applied Plant Science	2
	PLB	105	Plant Biology	3
3.	Complete a minimum of 10 credits from the following:			
	ANS	110	Introductory Animal Agriculture	4
	AT	291	Selected Topics in Agricultural Technology	2
	AT	293	Professional Internship in Agricultural Technology	3
	CSS	101	Introduction to Crop Science	3
	CSS	110	Computer Applications in Agronomy	2
	CSS	201	Forage Crops	3
	CSS	210	Fundamentals of Soil Science	3
	CSS	212	Advanced Crop Production	2
	CSS	360	Soil Biology	3
	HRT	221	Greenhouse Structures and Management	3
	HRT	244	Culinary and Medicinal Herbs	1
	HRT	245	Specialty Cut Flowers	1
	HRT	290	Independent Study in Horticulture	1 or 2
	HRT	332	Tree Fruit Production and Management	2
	HRT	335	Berry Crop Production and Management	1
	HRT	341	Vegetable Production and Management	3
	PLP	105	Fundementals of Applied Plant Pathology	2

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.

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.

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

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. Veter-

ans 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.

MICHIGAN AGRICULTURAL EXPERIMENT STATION

Steven G. Pueppke, Director

The research programs of the Michigan Agricultural Experiment Station (MAES) help to keep Michigan agriculture competitive, foster stewardship of natural resources, keep the food system safe, build stronger families and communities, and spur economic development in the state's cities, regions and industries. The mission of the MAES, to generate knowledge through strategic research that helps Michigan, is an integral part of Michigan State University's responsibilities as a land-grant university.

Based in the College of Agriculture and Natural Resources (CANR), the MAES is a network of laboratories and field stations across the state. More than 300 scientists from twenty-seven academic departments, research institutes and laboratories receive support from the MAES. Beyond CANR, the MAES is affiliated with the College of Natural Science, the College of Social Science, and the College of Veterinary Medicine.

The MAES 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 and health issues, including nutritional immunology, food security, emerging and re-emerging infectious diseases, and agro-security. Research also concentrates on community and economic development, youth mentoring, recreation and tourism, land cover policy, and water quality and watershed management.

In East Lansing, MAES research is conducted in laboratories, greenhouses, and several south campus experimental plots. The 15 off-campus field stations range from a tree research center in the Upper Peninsula to fruit and vegetable research farms in the southernmost counties of the state.

The MAES, like the larger land-grant tradition of which it is a part, is about more than agriculture. It is about an idea for higher education that combines practical information with traditional scientific studies to generate knowledge for a rapidly changing state and nation.

Organized under the Hatch Act of 1887, the MAES 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 associations, industries, foundations, and individuals.

MICHIGAN STATE UNIVERSITY EXTENSION

Thomas G. Coon, Director

Michigan State University Extension helps people improve their lives through an educational process that applies knowledge to critical issues, needs and opportunities. An educational outreach arm of Michigan State University, Michigan State University Extension has offices in all Michigan counties and a network of locally based Extension educators who help citizens access and use the knowledge resources of Michigan State University. Campus–based faculty members in four Michigan State University colleges share expertise derived from research and other scholarly activities to support local Extension programs. Michigan State University Extension, established in 1914, is part of a national educational system based in the nation's land–grant universities, and funded jointly by the U.S. Department of Agriculture, state and local governments.

Extension programming is focused in three basic areas:

Agriculture and Natural Resources Programs

The complexities of Michigan's agricultural and natural resource sectors require a comprehensive focus. Programming in agricultural technologies, management, and effective marketing helps commercial producers use cutting-edge production practices and business management to maximize their profits while protecting the environment. Educational assistance in natural resources topics helps citizens and leaders manage the state's natural resources responsibly and effectively. They need up-to-date information and technology to make wise stewardship decisions related to land use management, planning and zoning, and environmental quality.

Extension agricultural programs are designed to help growers efficiently produce commodities, assure adequate supplies of

high-quality agricultural products, maintain profitable farm operations and keep the state's multibillion–dollar agricultural industry competitive in national and world markets.

The same knowledge and expertise available to commercial agriculture is offered also to small farms, specialty growers and part-time producers. In addition, Extension directs a strong program to assist home gardeners and landscapers.

Extension programs in natural resources emphasize wise use and conservation of forests, water and wildlife; planning and maintaining orderly community development for social and economic progress and environmental quality; and Great Lakes development and coastal resource management through the Michigan Sea Grant Program.

Economic and Community Development Programs

Michigan State University Extension's Community and Economic Development Programs provide education and technical assistance to local government officials, operators of small and medium–sized businesses, economic and community development organizations, and other groups involved in local decision-making and actions to enhance economic well–being and quality of life in Michigan.

Responding to the needs of both businesses and communities means focusing on issues related to business and community vitality, economic development, employment and income, growth management, local government operation and inter–governmental cooperation, understanding, participation and decision-making. Current programs center attention on increasing economic competitiveness in business; initiating or enhancing industry–specific programs in forestry and wood products, food processing, and tourism; improving economic and human resource development programs; and providing public affairs and public policy education for local government officials and citizens.

Programs promote active and representative citizen participation that encourage residents to influence decisions that affect them meaningfully; engage community members in problem identification to improve understanding of the local situation; help community members understand the possible economic, social, political, environmental and psychological impacts of alternative solutions to problems; and to assist community members in using shared leadership, partnerships and other collaborative efforts to design and implement plans to solve local problems.

Children, Youth and Family Programs

Michigan State University Extension Children, Youth and Family Programs address the needs and priority issues affecting people throughout their lives. Programs bring together the expertise of professionals in Human Ecology, 4–H youth programs and Family and Consumer Science programs to deliver learning opportunities that recognize the interrelationships between children, young people, families and the communities in which they live.

This diverse group of staff members—in collaboration with other educators, researchers, agencies, organizations, community leaders and volunteers—help build effective coalitions to enable children, youth and families to develop their full potential as leaders and initiate positive change throughout their lives.

4–H Youth Development relies on volunteers to provide positive, hands–on educational opportunities with and for young people. 4–H programs help create environments that promote the development of strong, healthy young people who are prepared to succeed in today's complex and changing world.

4–H programs are available to young people ages 5 to nineteen. Trained volunteers conduct hands–on learning activities in a wide variety of settings, including clubs, community and learning centers, schools and camps. Often 4–H works through partnerships with other youth–serving organizations, human service agencies, business and industry, government and educational groups.

Family Consumer Science programs help families identify needs and offer education to improve the quality of life at home and in the community. Priority target audiences include limited–resource families, parents with young children, adult children of aging parents and senior citizens. Content includes nutrition and health, money management, parenting education and human development.

MSU PRODUCT CENTER for AGRICULTURE and NATURAL RESOURCES

H. Christopher Peterson, Director

The MSU Product Center for Agriculture and Natural Resources was established in 2003, by the Michigan Agricultural Experiment Station and Michigan State University Extension, to improve economic opportunities in the Michigan agriculture, food and natural resource sectors. The Center has three interrelated programs: the ANR Innovation Counselors Network, the Strategic Marketing Institute, and the Innovation Academy. They deliver coordinated responses to entrepreneurs and managers who are developing and commercializing high value, consumer responsive products and businesses with a natural resource or agricultural base.

The ANR Innovation Counselors Network, the outreach arm, is the local contact for entrepreneurial groups and existing businesses. Its counselors nurture new market and product development opportunities. At the Center level, project specialists assist counselors or firms directly by tapping into Michigan State University's technical expertise. Project specialists also collaborate with external consultants, industry groups and governmental agencies.

The Strategic Marketing Institute, the marketing arm, develops the information base needed to support initial screening and evaluation of concepts, products and businesses. It produces long-range studies for Michigan's agricultural, food and natural resource sectors. Each study includes an assessment of: core competencies, competitive advantages, strategic resource bases, supply chain configuration, promising business or product areas, futuring scenarios, and key strategic issues for the particular sector such as the commercialization of new technologies arising from university research.

The Innovation Academy, the leadership arm, meets the needs of managers, board members and entrepreneurs of agricultural, food and natural resource systems while building capacity for potential new industry leaders.

INSTITUTE of INTERNATIONAL AGRICULTURE

Daniel C. Clay, Director

The Institute of International Agriculture is administered jointly by the College of Agriculture and Natural Resources and International Studies and Programs. This Institute 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 Institute include the broad areas of international training, research, overseas institution building, and rural development abroad.

The Institute of International Agriculture is linked with the Colleges of Natural Science, Human Ecology, and Veterinary Medicine. When appropriate, the Institute interacts with additional colleges such as The Eli Broad College of Business, Education, Human Medicine, Osteopathic Medicine, and Veterinary Medicine.

Approximately 250 graduate students from 70 countries are enrolled in the College of Agriculture and Natural Resources. Each year more than 200 international agricultural scientists visit the College to discuss problems and areas of mutual interest. Formal and informal linkages with more than 20 institutions around the world provide for the exchange of faculty, graduate students, technical information and publications, and seed stock.

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 Institute of Water Research was established by Michigan State University in 1961 to promote and coordinate water research, education, and advisory services for the inland waters and Great Lakes of Michigan.

The Institute of Water Research develops interdisciplinary plans and research programs, assists in the development of departmental resources in support of water research, and provides a focal point to which the university community and off–campus groups can turn for advice and assistance. It is one of 54 state centers designated by the U. S. Geological Survey, U. S. Department of the Interior, to administer research funds authorized under PL 98–242, the Water Research Resources Act of 1984. With this base and through private, state, and federal funds, research projects are sponsored and facilities and services are provided for many departments on campus and in other universities. The active research programs include aspects of socio–economic water planning, water conservation, groundwater education, water quality, agriculture, fisheries, advanced waste utilization and treatment, limnology, and other disciplines. Graduate students in academic departments are supported with funds administered through the Institute.

The Institute of Water Research serves as a center for the dissemination of technical and nontechnical information on water research by maintaining extensive current documentation; publishing a monthly newsletter; convening conferences; and developing the Inland Lakes Research and Study Center, a research and demonstration facility for lake management strategies. The Institute of Water Research and the Center for Remote Sensing have formed the Land and Water Systems Partnership. The Institute also manages the Groundwater Education in Michigan (GEM) Program, assisting local governments and citizens groups to develop local groundwater education programs.