College of AGRICULTURE and NATURAL RESOURCES

William W. Taylor,
Acting DEAN

Michigan's only agricultural college, founded during an era of unregulated use of soils, water, forests and wildlife, was the first institution in the world to teach scientific agriculture. From its earliest beginnings, what is now the College of Agriculture and Natural Resources has educated men and women to be scientists and stewards of our natural resources.

Exemplifying the excellence of the land grant tradition, research performed by faculty in the College of Agriculture and Natural Resources creates breakthroughs in technology. The faculty integrate this new knowledge into subject matter presented in courses and extend that knowledge to the community, state, nation and beyond. Students in today's College of Agriculture and Natural Resources learn to manage resources and people to improve the use, conservation and renewal of the natural and fabricated environment.

Academic programs apply biological, physical, social and business sciences to the management of natural resources, agriculture, food, materials, and regions and communities in an international, environmentally sound framework. Graduates of these programs continue the traditions of excellence which provide the necessary elements for sustainability of food, prosperity and leisure activities in a world environment which has finite resources.

To prepare students for the many career opportunities in the food, natural resources and leisure industries, the College offers programs leading to degrees at the bachelor's, master's, and doctoral levels. For those interested in shortterm certificate programs, the Institute of Agricultural Technology offers a variety of technical programs which are less than two years in length.

UNDERGRADUATE PROGRAMS

In each of these programs, the College has developed a highly student–oriented advising system. Students are assigned an academic adviser to suggest courses and career emphases. In the student–adviser relationship, the capabilities, aspirations and goals of the students remain paramount throughout their academic careers.

For students who select agriculture or natural resources as their fields of study, but wish to delay their choice of a specific field until a later date, a no–preference program is offered. Under this arrangement freshmen who are enrolled in the Undergraduate University Division may designate their major preferences 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: Agriscience, Agriculture and Natural Resources Communications, Animal Science, Building Construction Management, Crop and Soil Sciences, Fisheries and Wildlife, Food Science, Food Industry Management and Agribusiness Management, Forestry, Horticulture, Packaging, Park, Recreation and Tourism Resources, Public Resource Management, and Environmental Studies and Appications.

The College of Agriculture and Natural Resources cooperates with the College of Engineering in offering an undergraduate program in Biosystems Engineering.

Honors Study

The College of Agriculture and Natural Resources encourages honors students to develop enriched and distinctive undergraduate programs. In each of the major fields offered by the several departments, members of the faculty are carefully selected to serve as Departmental Honors College Advisers. It is the responsibility of these advisers to assist each Honors College student in planning a rigorous and balanced program that reflects special 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 them 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.

Computer Applications. It is estimated that seventy percent of the jobs in the United States are related in some direct way to computers. Employers of all types are anxious to employ college graduates who have some familiarity with computer technology. To help meet this need, the College makes it possible for students in any of its majors to obtain training in computer applications. Courses are available in the Department of Computer Science and Engineering. In addition, several departments in the College of Agriculture and Natural Resources offer courses in which special emphasis is given to the application of computer techniques in specific subject matter areas. The College has several Microcomputer Laboratories designed to assist students in computer applications.

International Agriculture. 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. In addition to formal class work, faculty–student seminars are presented and overseas summer study programs are available.

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

Freshmen

Students meeting the general requirements for admission shown in the *Undergraduate Education* section are enrolled in the Undergraduate University Division but may declare a major preference in the College of Agriculture and Natural Resources and be assigned an academic adviser in the College

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 numbers of students admitted as juniors to the building construction management major and the packaging major are limited. For additional information, refer to the statements on the Department of Agricultural Engineering and the School of Packaging.

Graduation Requirements

1. The University requirements for bachelor's degrees as described in the *Undergraduate Education* section of the 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. Mathematics 110 or 116. This requirement may be satisfied by placing into a calculus course based on a MSU placement test.
   b. Economics 201 or 202.
   c. Agriculture and Natural Resources 489.
   d. At least 26 credits in courses in the College including Agriculture and Natural Resources 489.
   e. 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 (11 credits):			
	BCH	401	Basic Biochemistry	4
	CSS	451	Cellular and Molecular Principles and Techniques for Plant Sciences	4
	HRT	486	Biotechnology in Agriculture: Applications and Ethical Issues	3
2.	One of the following courses (3 or 4 credits):			
	CSS	350	Introduction to Plant Genetics	3
	ZOL	341	Fundamental 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 in the College of Agriculture and Natural Resources 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 Foundations in Connected Learning	3
		ANR	310 Connected Learning Seminar I	2
		ANR	311 Connected Learning Seminar II	1
		ANR	410 Connected Learning Application	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.

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 or environmental science disciplinary minor, must contact the Department of Agriculture and Natural Resources Education and Communication Systems.

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

The College of Agriculture and Natural Resources through its graduate programs 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; agricultural and extension education; agricultural engineering; agricultural technology and systems management; animal science; building construction management; crop and soil sciences; fisheries and wildlife; food science; forestry; forestry–urban studies; horticulture; packaging; park, recreation and tourism resources; park, recreation and tourism resources–urban studies; plant breeding and genetics–crop and soil sciences; plant breeding and genetics–forestry; plant breeding and genetics–horticulture; resource development; and resource development–urban studies. 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 Doctor of Philosophy degree may be earned with majors in agricultural economics; agricultural and extension education; agricultural engineering; agricultural technology and systems management; animal science; crop and soil sciences; fisheries and wildlife; food science; forestry; forestry–urban studies; horticulture; park, recreation and tourism resources; park, recreation and tourism resources–urban studies; plant breeding and genetics–crop and soil sciences; plant breeding and genetics–forestry; plant breeding and genetics–horticulture; resource development; and resource development–urban studies.

The following dual Juris Doctor (JD) programs with Michigan State University - Detroit College of Law are available through the College of Agriculture and Natural Resources: MSU MS degree program with a major in Fisheries and Wildlife andMSU/DCL JD; MSU MS degree program with a major in Forestry and MSU/DCL JD; MSU MS degree program with a major in Forestry-Urban Studies and MSU/DCL JD; MSU MS degree program with a major in Park, Recreation and Tourism Resources and MSU/DCL JD; MSU MS degree program with a major in Park, Recreation and Tourism Resources-Urban Studies and MSU/DCL JD; MSU MS degree program with a major in Resource Development and MSU/DCL JD; MSU MS degree program with a major in Resource Development-Urban Studies andMSU/DCL JD; MSU Ph.D. degree program with a major in Park, Recreation and Tourism Resources and MSU/DCL JD; MSU Ph.D. degree program with a major in Park, Recreation and Tourism Resources-Urban Studies and MSU/DCL JD.

The departments of Botany and 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 information about a Doctor of Philosophy degree program that involves ecology, evolutionary biology and behavior and a major in one of the departments referenced above, 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'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 *Master's Specialization in Agribusiness* statement in the *Department of Agricultural Economics* statement.

Students who are enrolled in Master of Science degree programs in the departments of Botany and Plant Pathology, Crop and Soil Sciences, Entomology, Fisheries and Wildlife, Forestry, and 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 and Doctor of Philosophy degree programs in the Department of Food Science and Human Nutrition may elect specializations in infant studies. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Infant Studies* 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 Economics; Fisheries and Wildlife; Forestry; Park, Recreation and Tourism Resources; and Resource Development may elect specializations in resource economics. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Resource Economics.*

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.

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 degree or its equivalent; however, completion of a master's degree or its equivalent is not a guarantee of admission to a doctoral program.

It is usually desirable, but not mandatory, that a student earn a master's degree before proceeding to a doctoral program. Students who plan to pursue work toward a doctorate without earning a master's degree will be enrolled as master's students until they have earned 30 graduate credits.

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

Examinations

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

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

Academic Standards

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

Residence

One 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 and GENETICS

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

The interdepartmental graduate program in Plant Breeding and Genetics 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 and Genetics 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 and Genetics faculty. Admission to the program is by approval of one of the four participating departments, the Plant Breeding and Genetics faculty, and the Coordinator of

the Plant Breeding and Genetics 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 and Genetics 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 and Genetics 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 and Genetics faculty. The degree is conferred upon recommendation of the department, the Coordinator of the Plant Breeding and Genetics 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 and Genetics 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 and Genetics faculty. Admission to the program is by approval of one of the four participating departments, the Plant Breeding and Genetics faculty, and the Coordinator of the Plant Breeding and Genetics 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 and Genetics 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 and Genetics faculty. One semester of teaching experience is also required.

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

GRADUATE SPECIALIZATION in ENVIRONMENTAL TOXICOLOGY

The College of Agriculture and Natural Resources, the College of Engineering, and the College of Natural Science 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, Crop and Soil Sciences, Entomology, Fisheries and Wildlife, Food Science and Human Nutrition, Geological Sciences, Resource Development, 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 adviser for the specialization. The academic adviser 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 adviser 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
	FW	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
	FW	878	Dynamics of Trace Contaminants in Aquatic Systems	3
	GLG	421	Environmental Geochemistry	4
	GLG	821	Aqueous Geochemistry	3

MIC	425	Microbial Ecology	3
MIC	841	Soil Microbiology	3
ZOL	897	Community and Ecosystem Ecology	4
Economics, Policy, and Law			
AEC	810	Institutional and Behavioral Economics	3
AEC	829	The Economics of Environmental Resources	3
RD	415	Introduction to Impact Assessment	4
RD	828	Attitudes, Behavior and Environmental Sustainability	3
RD	936	Advanced Environmental Law	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
BCH	960	Selected Topics in Biochemistry I[1]	1 to 7
FSC	807	Advanced Food Toxicology	3
FSC	840	Advanced Food Microbiology	3
FW	831	Aquatic Toxicology	4
OSS	512	Biostatistics and Epidemiology	2
PHM	815	Concepts in Tumorigenesis	2
PTH	856	Pathotoxicology	3

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

[1] This course may be counted toward the requirements for the specialization only when the topic deals with 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.

INTERDEPARTMENTAL GRADUATE SPECIALIZATIONS in RESOURCE ECONOMICS

Interdepartmental graduate specializations in resource economics are available as electives for students who are enrolled in master's and doctoral degree programs in the departments of Agricultural Economics; Fisheries and Wildlife; Forestry; Park, Recreation and Tourism Resources; Resource Development; and Economics. The College of Agriculture and Natural Resources, and The Eli Broad College of Business and The Eli Broad Graduate School of Management, administer these specializations; the College of Agriculture and Natural Resources is the primary administrative unit.

Persons who have been identified by the chairpersons of the six participating departments are members of the Resource Economics core faculty or associated faculty. The Coordinating Committee of Resource Economics faculty is composed of one faculty member from each of the six departments. The faculty members who comprise the core faculty and associated faculty may change with the mutual consent of the chairpersons of the departments, upon recommendation of the Coordinating Committee.

The interdepartmental graduate specializations in resource economics are designed to:

1. Provide an opportunity for graduate students to obtain a comprehensive and contemporary academic experience in the field of natural resource economics.
2. Help graduate students with an interest in natural resource economics to become sensitive to their professional obligations and responsibilities.
3. Develop an intellectual environment which will foster the growth of research and public service in the area of natural resource economics.
4. Increase public awareness of natural resources problems and alternative solutions.

Students who elect the interdepartmental graduate specializations in resource economics should have some background in the physical or biological sciences, natural resource management, or plant and animal ecology. If in the judgment of the student's guidance committee addition al academic preparation is appropriate, the student may be required to complete some collateral courses.

Requirements for the Specializations in Resource Economics

Master's Students: The specialization consists of the completion of the courses specified by the Coordinating Committee of Resource Economics faculty. Although the student should anticipate completing approximately 17 credits in resource economics courses, such credits may also be counted toward the requirements for the student's major at the discretion of the department.

Doctoral Students: The specialization consists of the completion of the courses specified by the Coordinating Committee of Resource Economics faculty and the passing of a written examination prepared and administered by three members of the Resource Economics core faculty selected by the Coordinating Committee with the approval of the chairpersons of the participating departments . Credits that are used to meet the requirements for the specialization may also be counted toward the requirements for the student's major at the discretion of the department. One member of the core faculty will serve on the student's guidance committee.

Upon completion of the requirements for the degree program and of the interdepartmental graduate specialization in resource economics, the student should contact the chairperson of his or her 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 AGRICULTURE and NATURAL RESOURCES EDUCATION and COMMUNICATION SYSTEMS

Kirk L. Heinze, Acting Chairperson

The Department of Agriculture and Natural Resources Communication and Education systems offers programs leading to the Bachelor of Science, Master of Science, and Doctor of Philosophy degrees. It also conducts research and develops programs in the areas of agriculture and natural resources–related communications, personnel development, instructional strategies, leadership, program evaluation, distance learning, organizational management, extension, and international agriculture.

Credit and non–credit courses, both on and off campus, are offered for MSU extension personnel and teachers of agriscience. Workshops and seminars are conducted to provide professional development for those involved in the agricultural and natural resources industries.

Through an educational materials distribution service, individual instructional units and other materials are made available to the general public, teachers and Extension field staff. Faculty also provide leadership for many student organizations.

UNDERGRADUATE PROGRAMS

The department offers two undergraduate programs that lead to the Bachelor of Science degree: a) a major in Agriscience with options in Agribusiness Management, Animal Science, Fisheries and Wildlife, Food Industry, Horticulture and Teacher Certification, and b) a major in Agricultural and Natural Resources Communications with options in Agriculture and Natural Resources.

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.

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 Agriculture and Natural Resources Education and Communication Systems 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. *One* of the following *six* options:

Agribusiness Management (18 credits)
Students interested in this option must fulfill the requirements for the Specialization in Agribusiness Management listed in the Department of Agricultural Economics section of this catalog.

Animal Science (23 credits)

(1) All of the following courses:

ANS	210	Animal Products	4
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

(2) Two of the following courses:

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

Fisheries and Wildlife (22 credits):

(1) All of the following courses:
FW 205 Principles of Fisheries and Wildlife Management 3
FW 324 Wildlife Biometry 3
FW 355 Ecology 3

(2) One of the following courses:
FW 203 Resource Ecology 3
FW 207 Great Lakes: Biology and Management 3
FW 284 Natural History and Conservation in Michigan 3

(3) One of the following courses:
FW 462 Ecology and Management of Invertebrates . 4
FW 471 Ichthyology 4
ZOL 360 Biology of Birds 4
ZOL 365 Biology of Mammals 4
ZOL 384 Biology of Amphibians and Reptiles 4

(4) Two of the following courses:
FW 364 Ecosystem Processes 3
FW 410 Upland Ecosystems Management 3
FW 412 Wetland Ecosystems Management 3
FW 414 Aquatic Ecosystem Management 3

Food Industry (18 credits)

Students interested in this option must fulfill the requirements for the Specialization in Food Industry Management listed in the Department of Agricultural Economics section of this catalog.

Horticulture (21 credits)

(1) All of the following courses:
HRT 204 Principles of Horticulture II 2
HRT 204L Principles of Horticulture II Laboratory . . . 1
HRT 210 Nursery Management 3
HRT 221 Greenhouse Structures and Management . . 3
HRT 331 Tree and Small Fruit Production and Management 3
HRT 341 Vegetable Production and Management . . . 3

(2) One of the following courses:
HRT 403 Handling and Storage of Horticultural Crops 3
HRT 407 Horticulture Marketing 3

(3) One of the following courses:
HRT 322 Greenhouse Production I: Potted Plants . . . 3
HRT 323 Greenhouse Production II: Cut Flowers and Bedding Plants 3

Teacher Certification (21 credits)

Please refer to the statement on Teacher Certification Options in the Department of Agriculture and Natural Resources Education and Comunication Systems.

(1) All of the following courses:
TE 150 Reflections on Learning 3
TE 301 Learners and Learning in Context (W) 4
TE 401 Teaching of Subject Matter to Diverse Learners (W) 5
TE 402 Crafting Teaching Practice (W) 6

(2) One of the following courses:
CEP 240 Diverse Learners in Multicultural Perspective 3
TE 250 Human Diversity, Power, and Opportunity in Social Institutions 3

AGRICULTURE and NATURAL RESOURCES COMMUNICATIONS

The agriculture and natural resources communications major is designed to prepare students for careers in agriculture and natural resources journalism, public relations, advertising, broadcasting, or marketing communications. Professionals combine agriculture and natural resources subject-matter knowledge with skills in writing, speaking, photography, layout and design, and information management. Interviewing agricultural producers, scientists, and agribusiness and political leaders; attending press conferences, trade shows, and legislative sessions; reporting new products and trends; preparing and executing communications plans; and developing web sites and CD-ROMS for clients are some of the exciting activities of agriculture and natural resources communicators.

Colleges, advertising and public relations agencies, trade associations, government agencies, extension services, and corporations need men and women who can tell the story of agriculture and natural resources to a variety of audiences. Success in these organizations may lead to positions as editors, advertising account supervisors, public relations directors, and marketing communications managers.

The agriculture and natural resources communications major is offered in cooperation with the College of Communication Arts and Sciences.

Requirements for the Bachelor of Science Degree in Agriculture and Natural Resources Communications

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

   The University's Tier II writing requirement for the Agriculture and Natural Resources Communications major is met by completing Agriculture and Natural Resources Education and Communication Systems 300, 311, 410, and 411. 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 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 in the Department of Agriculture and Natural Resources Education: and Communication Systems . . . . . 19 to 22
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 to 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 to 6

b. The following courses outside the Department of Agriculture and Natural Resources Education nd Communication Systems: . . . . . 38 or 39

(1) All of the following courses (12 credits):
ADV 227 Principles of Public Relations 4
JRN 200 News Writing and Reporting I 4
JRN 300 News Writing and Reporting II 4

(2) One of the following courses (3 or 4 credits):
COM 225 Introduction to Interpersonal Communication 3
COM 240 Introduction to Organizational Communication 4

(3) Eleven additional credits in courses in the College of Communication Arts and Sciences, at least 6 of which must be in 300–400 level courses.

(4) One of the following two options (12 credits):

Option I: Natural Resources. Twelve credits from the following courses:
FOR 204 Forest Vegetation 4
FOR 220 Forests and the Global Environment 3
FW 203 Resource Ecology 3
FW 284 Natural History and Conservation in Michigan 3
PRR 213 Introduction to Parks, Recreation and Leisure 3
PRR 302 Environmental Attitudes and Concepts 3
PRR 351 Recreation and Natural Resources Communication (W) 3
RD 201 Environmental and Natural Resources 3

Option II: Agriculture. Twelve credits from the following courses:

ANS	110	Introductory Animal Agriculture	4
CSS	101	Introduction to Crop Science	3
CSS	210	Fundamentals of Soil and Landscape Science	3
FSM	200	Introduction to Food Systems Management	3
FSM	325	Agribusiness Labor and Personnel Management	3
FSM	330	Farm Business Management	3
HRT	100	Horticulture: Plants and People	3
PRM	260	World Food, Population and Poverty	3

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 and an environmental science disciplinary minor are also available for teacher certification.

Students who elect the agriscience disciplinary major, or the agriscience or environmental science disciplinary minor, must contact the Department of Agriculture and Natural Resources Education and Communication Systems.

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

GRADUATE STUDY

Graduate programs in agricultural and extension education are offered that lead to the Master of Science and Doctor of Philosophy degrees. These programs provide for advanced study and research in two major areas: agricultural education and extension education.

The master's and doctoral degree programs in agricultural and extension education consist of a planned course of study that leads to the acquisition of specific knowledge, skills, and abilities. Students and faculty engaged in these programs become part of a community committed to the rigorous study and application of the concepts of education, teaching and learning. The program recognizes that each student has unique needs and abilities that must be addressed in an individual manner. Graduates may be employed in various settings including higher education public schools, distance education organizations, agribusiness government agencies, and extension programs.

Special emphasis is available in the areas of distance education and evaluation research. Students may also meet the requirements for teacher certification, in addition to the requirements for a graduate degree.

Master of Science

The master's degree program in agricultural and extension education has been planned for students who may have widely different backgrounds and post–degree plans. All students are expected to obtain sufficient foundations of education and learning to permit utilization of those concepts in the fields of agricultural and extension education.

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

Admission

To be admitted to regular status, students must have (1) a baccalaureate degree in a field related to either agricultural or extension education, (2) a grade–point average of 3.00 or higher for the last two years of their undergraduate programs, and (3) at least one year of successful professional experience in teaching agriculture or in extension education, or equivalent professional experience acceptable to the department.

Persons who have met the first two requirements for admission to regular status, but who have not met the third requirement, may be admitted to regular status. If admitted to regular status, however, such individuals will be required to complete a practicum experience through collateral courses or to have at least one year of successful professional experience acceptable to the department before the degree will be granted.

Persons who have not met the requirements for admission to regular status may be admitted to provisional status. If admitted to provisional status, students may be required to complete collateral courses, in addition to the minimum requirements for the master's degree. If admitted to provisional status and then to regular status without having met the third requirement for admission to the program, individuals will be required to complete a practicum experience through collateral courses or to have at least one year of successful professional experience acceptable to the department before the degree will be granted.

Requirements for the Master of Science Degree in Agricultural and Extension Education

A minimum of 33 credits is required for the Master of Science degree in agricultural and extension education under either Plan A (with thesis) or Plan B (without thesis).

Two areas of emphasis are available for the master's degree. The first area is for licensed (certified) teachers of agriculture. The second area is for professionals in extension education. The distribution of credits for both areas of emphasis is as follows:

	CREDITS
Core Courses	9
Emphasis Area Courses	9
Cognate Area Courses	9
Thesis or Applied Project	6

Students may elect Plan A (Thesis) or Plan B (Applied Project). Students who elect Plan A must complete a minimum of 6 credits of Agriculture and Natural Resources Education and Communication Systems 899, Master's Thesis Research. Students who elect Plan B must complete a minimum of 3 credits of Agriculture and Natural Resources Education and Communication Systems 898, Master's Applied Project and 3 credits of Agriculture and Natural Resources Education and Communication Systems 893, Professional Field Experience. Such credits are included in the total number of credits required for the degree.

Students who were admitted to the program without one year of successful professional experience must meet the additional requirement specified in the statement on admission.

Doctor of Philosophy

The doctoral degree program in agricultural and extension education is a research-based degree program created for the educator wanting to pursue advanced graduate studies leading to leadership positions in college/university teaching;

state, national or international extension organizations; non-government organizations; educational curriculum development; teacher preparation/supervision; and research, development, and implementation in the areas of distance education and evaluation research.

The program is built on the assumption that all entering students will have developed and practiced the competencies and skills that form the foundation of the Master's Program in Agricultural and Extension Education. Study and research at the doctoral level is framed by knowledge of food, agriculture, renewable resources and the environment and uses these areas as the basis for application of appropriate educational practice.

Students enrolled in the doctoral program develop a highly individualized program plan of courses, research and guided experience that is based on their own unique background, experience and career objective.

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, applicants must submit a resume, a goal statement, two essays written in response to questions prepared by the faculty, and a statement describing the applicant's area of research interest. The applicant may also be required to participate in an interview..

To be admitted to regular status, students must have (1) a master's degree in a field related to either agricultural or extension education, (2) a grade–point average of 3.00 or higher in all previous graduate work, and (3) relevant and recent professional experience.

Persons who have not met the requirements for admission to regular status may be admitted to provisional status. If admitted to provisional status, students may be required to complete collateral courses, in addition to the minimal requirements for the doctoral degree.

Requirements for the Doctor of Philosophy Degree in Agricultural and Extension Education

Each student's program of study is the responsibility of the guidance committee in consultation with the student. The guidance committee consists of at least four persons: the major professor and one other person from the department, one faculty member from another department in the College, and a faculty member representing the cognate area of study. The guidance committee insures that the department, College, and University requirements are met.

A typical doctoral student completes in a satisfactory manner, a program of study including 40 to 50 course credits beyond the master's degree, including three courses in statistics and/or research methodology. The student must also prepare and submit for publication a research-based article in support of the student's area of research interest. A comprehensive examination must be passed after approximately 80% of the course work has been completed, and a research-based doctoral dissertation must be successfully defended to complete the degree program.

DEPARTMENT of AGRICULTURAL ECONOMICS

Larry G. Hamm, Chairperson

UNDERGRADUATE PROGRAMS

The department offers three undergraduate majors: agribusiness management, food industry management, and public resource 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 advisers 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 Agriculture and Natural Resources 489 and Agribusiness Management 437. Those courses are referenced in items 2. and 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:*			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[1]	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

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
- GBL 323 Introduction to Business Law. 3
- HED 373 Merchandising Management Entrepreneurship 3
- PRM 405 Corporate Environmental Management 3

c. *One of the following courses:* 3
- ABM 427 Global Agri-Food Industries Markets. 3
- PRM 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 Public Resource Management 9

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

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, recognizaes 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 aplications 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 Agriculture and Natural Resources 489 and Food Industry Management 439. Those courses are referenced in items 2. and 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: 38
- ACC 230 Survey of Accounting Concepts. 3
- CSE 101 Computing Concepts and Competencies[1] 3
- EC 201 Introduction to Microeconomics 3
- EC 202 Introduction to Macroeconomics 3
- FI 320 Introduction to Finance. 3
- FIM 100 Decision-making in the Agri-Food System. 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

b. Four of the following courses: 12
- ABM 222 Agribusiness and Food Industry Sales (W) 3
- ABM 225 Commodity Marketing 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 435 Financial Management in the Agri-Food System 3

c. Two of the following courses: 6
- GBL 323 Introduction to Business Law. 3
- HED 363 Promotional Strategies in Marketing. 3
- HED 373 Merchandising Management Entrepreneurship 3
- HED 465 International Consumer Distribution Systems . 3
- MSC 302 Consumer and Organizational Buyer Behavior 3
- MSC 335 Food Marketing Management. 3

d. One of the following courses: 3
- ABM 427 Global Agri-Food Industries and Markets 3
- PRM 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, Human Environment and Design, Hospitality Business, Human Nutrition and Foods, Packaging, and Public Resource Management. . . . 9

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

PUBLIC RESOURCE MANAGEMENT

Public Resource Management is the study of the methods and processes necessary to identify and analyze policy alternatives, and to develop community leadership, decision making capacity, and management of public resources. The major is designed to provide an integrated, broad perspective of public finance, economic development, community and regional studies, social services, social ecology and population settlement patterns, the use of the natural environment, science, technology, law, and social change.

The Public Resource Management major is designed to prepare students for employment in local, state, and national governments (domestic and international), community and service organizations, and private sector governmental affairs departments. The focus is on policy analysis, planning, evaluation, budgeting, and program management in governmental agencies, community organizations, volunteer and not–for–profit organizations, citizen groups, and lobbying and public affairs departments of corporations. The program is also designed to prepare students for law school and graduate programs in public administration and policy analysis, economics, sociology, education (extension), and resource management.

Requirements for the Bachelor of Science Degree in Public Resource 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 Public Resource Management.

   The University's Tier II writing requirement for the Public Resource Management major is met by completing Agriculture and Natural Resources 489 and Public Resource Management 404. Those courses are referenced in items 2. and 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:* 44
- ACC 230 Survey of Accounting Concepts. 3
- CSE 101 Computing Concepts and Competencies[1] 3
- EC 201 Introduction to Microeconomics 3
- EC 202 Introduction to Macroeconomics 3
- GEO 221 Introduction to Geographic Information 3
- PLS 200 Introduction to Political Science. 4

	PRM	201	Community Economics	3
	PRM	255	Ecological Economics	3
	PRM	260	World Food, Population and Poverty	3
	PRM	320	Environmental Economics	3
	PRM	404	Public Sector Budgeting and Program Evaluation (W)	3
	RD	460	Resource and Environmental Economics	3
	RD	470	Theory and Practice in Community and Economic Development	3
	SOC	100	Introduction to Sociology	4
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
	FW	203	Resource Ecology	3
	ISB	202	Applications of Environmental and Organismal Biology	3
d.	*One of the following courses:*			3
	MGT	302	Management and Organizational Behavior	3
	MGT	310	Human Resource Management (W)	3
	PSY	255	Industrial and Organizational Psychology	3
e.	*One of the following courses:*			3
	RD	430	Law and Resources	3
	RD	433	Law and Social Change	3
f.	*One of the following courses:*			3 or 4
	STT	200	Statistical Methods	3
	STT	201	Statistical Methods	4
	STT	315	Introduction to Probability and Statistics for Business	3
g.	Professional electives: At least 6 credits in applied policy courses approved in writing by the student's academic adviser. At least 3 of the 6 credits must be in courses in the College of Agriculture and Natural Resources			6

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

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 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:[1]			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
	HED	373	Merchandising Management Entrepreneurship	3
	MGT	325	Management Skills and Processes	3
	MSC	327	Introduction to Marketing	3
	MSC	335	Food Marketing Management	3

[1] Courses not used to satisfy requirements 1. and 2. may be used to substitute for courses listed in requirement 3.

Upon completion of the requirements for the specialization in agribusiness management, the student should contact the Chairperson of the Department of Agricultural Economics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Agricultural 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 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
	PRM	255	Ecological Economics	3
	PRM	320	Public Policy Analysis Methods	3
	RD	460	Resource and Environmental Economics	3
3.	One additional course related to environmental policy issues and approved by the academic adviser for environmental economics in the Department of Agricultural Economics.			

Upon completion of the requirements for the specialization in environmental economics, the student should contact the Chairperson of the Department of Agricultural Economics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Agricultural 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 Arts or Bachelor of Science degree program with a major in food industry management. The specialization is administered by the Department of Agricultural 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:			9
	ABM	100	Decision-making in the Agri-Food System	3
	FIM	220	Food Product Marketing	3
	MSC	351	Retail Management	3
2.	One of the following courses:			3
	ABM	222	Agribusiness and Food Industry Sales (W)	3
	ABM	337	Labor and Personnel Management in the Agri-Food System[1]	3
	ABM	400	Public Policy Issues in the Agri-Food System	3
	ABM	427	Global Agri-Food Industries and Markets	3
	ABM	435	Financial Management in the Agri-Food System	3
	ABM	439	Food Business Analysis and Strategic Planning (W)[1]	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
	GBL	323	Introduction to Business Law	3
	MGT	325	Management Skills and Processes	3
	MGT	327	Introduction to Marketing	3
	MSC	335	Marketing Management	3

[1] Students who do not use Food Industry Management 439 to satisfy requirement 2. may use this course to satisfy requirement 4.

Upon completion of the requirements for the specialization in food industry management, the student should contact the Chairperson of the Department of Agricultural Economics and request certification for the completion of the specialization. After the certification is approved by the Chairperson of the Department of Agricultural 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 Economics offers Master of Science and Doctor of Philosophy degree programs in agricultural economics. The department also offers a Doctor of Philosophy degree program in agricultural economics—environmental toxicology.

AGRICULTURAL ECONOMICS

Graduate programs in agricultural 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: food and agricultural marketing, agricultural firm management, international agricultural development, agricultural and trade policy, and environmental and resource economics.

Graduate students who are enrolled in the Department of Agricultural 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 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

A variety of undergraduate programs provides background for graduate study in agricultural 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 economics are required to submit scores for the General Test of the Graduate Record Examination. Applicants may apply directly for the Ph.D. program only if they will have completed a master's degree by the time of enrollment.

Master of Science

The master's programs in agricultural 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 Economics

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

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

Requirements for Both Plan A and Plan B:

1. A grade-point average of at least 3.00 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 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 EC 801) and one elective 3 credit quantitative methods course. Alternatively, students may replace EC 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 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 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 economics outside the major field, and (b) 6 credits in a second minor field that may be outside the Department of Agricultural 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 Economics.

AGRICULTURAL ECONOMICS—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in agricultural economics—environmental toxicology, refer to the statement on *Multidepartmental Doctoral Programs in Environmental Toxicology* in the *Graduate Education* section of this catalog.

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 Economics.

The student's program of study for the specialization must be approved by the academic adviser 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:[1]			3
	AEC	800	Foundations of Agricultural Economics	3
	EC	805	Microeconomic Analysis	3
2.	Two of the following courses:			6
	AEC	851	Agricultural Firm Management[2]	3
	AEC	853	Financial Management in Agriculture[2]	3
	AEC	857	Strategic Management in Agribusiness[2]	3
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[2]	3
	AEC	853	Financial Management in Agriculture[2]	3
	AEC	855	Agricultural Production Economics	3
	AEC	857	Strategic Management in Agribusiness[2]	3
	GBL	848	Legal Environment of Business	3
	LIR	823	Organizational Behavior in Labor and Industrial Relations[3]	3
	LIR	824	Human Resource Strategies and Decisions[4]	3
	LIR	825	Compensation and Benefit Systems	3
	LIR	858	Collective Bargaining	3
	MGT	806	Management and Organizational Behavior[3]	3
	MGT	810	Human Resource Management[4]	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[5]	2

[1] Requirement 1. will be waived for students who have completed an intermediate-level course in microeconomics.

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

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

[5] 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 require-

ments 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 AGRICULTURAL ENGINEERING

Ajit Srivastava, Chairperson

The Department of 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 building construction 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 Agricultural Engineering* in the *College of Engineering* section of this catalog.

BUILDING 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

Enrollment in the Building Construction Management major is 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–-point average of 2.00:
   - a. MTH 124 Survey of Calculus with Applications I
   - b. PHY 231 Introductory Physics I
   - c. STT 200 Statistical Methods
     or
     STT 201 Statistical Methods
     or
     STT 315 Introduction to Probability and Statistics for Business
     or
     STT 421 Statistics I
   - d. EC 201 Introduction to Microeconomics
     or
     EC 202 Introduction to Macroeconomics

The student's cumulative grade–point average for all courses completed is also 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 Department of Agricultural Engineering.

Requirements for the Bachelor of Science Degree in Building 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 Building Construction Management.

   The University's Tier II writing requirement for the Building Construction Management major is met by completing Building Construction Management 435 or 436. Those courses are referenced in item 3. b. below.

   Students who are enrolled in the Building Construction Management major leading to the Bachelor of Science degree in the Department of Agricultural Engineering 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* Botany and Plant Pathology 105 and 106 *or* Microbiology 205 and 206. The completion of Physics 251 *and* Biological Science 110 *or* 111L *or* Botany and Plant Pathology 106 *or* Microbiology 206 satisfies the laboratory requirement. With adviser approval, for this laboratory requirement, Biological Science 111L, Botany and Plant Pathology 106 and Microbiology 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 Botany and Plant Pathology 105 and 106 or Microbiology 205 and 206 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

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

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

				CREDITS
a.	*All of the following courses:*			64
	ACC	230	Survey of Accounting Concepts	3
	BCM	101	Principles of Building Construction Management	2
	BCM	124	Residential Construction Materials and Methods	3
	BCM	210	Commercial Construction Methods	3
	BCM	211	Building Codes	3
	BCM	222	Statics and Strengths of Materials	3
	BCM	230	Utility Systems	4
	BCM	305	Site Construction and Measurement	3
	BCM	315	Construction Quantity Surveying	3
	BCM	322	Structural Systems	3
	BCM	325	Real Estate Principles and Construction Finance	4
	BCM	328	Construction Presentation Graphics	2
	BCM	385	Construction Documents and Contracts	3
	BCM	401	Construction Safety Management	3
	BCM	403	Land Development	3
	BCM	411	Construction Project Scheduling	3
	BCM	415	Cost Estimating and Analysis	3
	BCM	423	Construction Project Management	3
	CSE	101	Computing Concepts and Competencies[1]	3
	MTH	124	Survey of Calculus with Applications I	3
	PHY	231	Introductory Physics I	3
	PHY	251	Introductory Physics Laboratory I	1
b.	*One of the following courses:*			3
	BCM	435	Residential Building Projects (W)	3
	BCM	436	Commercial Building Projects (W)	3
c.	*One of the following four choices:*			4 or 5
	(1) BS	110	Organisms and Populations	4
	(2) BS	111	Cells and Molecules	3
	BS	111L	Cell and Molecular Biology Laboratory	2
	(3) BOT	105	Plant Biology	3

		BOT	106	Plant Biology Laboratory	2
	(4)	MIC	205	Allied Health Microbiology	3
		MIC	206	Allied Health Microbiology Laboratory	1
d.	*One of the following courses:*				3 or 4
		CEM	141	General Chemistry	4
		CSE	131	Introduction to Technical Computing	3
		GLG	411	Hydrogeology	4
		MTH	126	Survey of Calculus with Applications II	3
		PHY	232	Introductory Physics II	3
e.	*One of the following courses:*				3 or 4
		COM	100	Human Communication	3
		COM	225	An Introduction to Interpersonal Communication	3
		COM	240	Introduction to Organizational Communication	4
f.	*One of the following courses:*				3 or 4
		STT	200	Statistical Methods	3
		STT	201	Statistical Methods	4
		STT	315	Introduction to Probability and Statistics for Business	3
g.	*One of the following courses*[2]*:*				3
		EC	201	Introduction to Microeconomics	3
		EC	202	Introduction to Macroeconomics	3
h.	*Three of the following courses:*				9
		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

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

[2] Whichever course was not used to satisfy 3.g. may be used as one of the three courses to satisfy requirement 3.h.

GRADUATE STUDY

The Department of Agricultural Engineering offers the programs listed below:

Master of Science

agricultural technology and systems management
biosystems engineering
building construction management

Doctor of Philosophy

agricultural technology and systems management
biosystems engineering

Study for the department's master's and doctoral degree programs is administered by the College of Agriculture and Natural Resources. Descriptions of the degree programs, organized by fields of study in alphabetical order, are presented below.

AGRICULTURAL TECHNOLOGY AND SYSTEMS MANAGEMENT

Agricultural technology and systems management emphasizes the application of system science to the planning and management of technology for optimum agricultural production and processing and for the preservation and utilization of natural resources.

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

For regular admission to the program, the student must have a Bachelor of Science degree in agricultural technology and systems management. The degree may have been earned through a college of agriculture and natural resources.

Provisional admission may be granted to an applicant who has a Bachelor of Science degree in a natural, biological, or physical science. Deficiencies must be removed by completing collateral courses.

Requirements for the Master of Science Degree in Agricultural Technology and Systems Management

The program is available only under Plan A (with thesis). A total of 30 credits is required for the degree. The student's program of study must be approved by the student's academic adviser and must include:

					CREDITS
1.	All of the following courses:				
		BE	820	Research Methods in Agricultural Engineering	1
		BE	892	Agricultural Engineering Seminar	1
		ATM	840	Analysis of Physical Systems	3
	Two additional courses in the College of Agriculture and Natural Resources at the 400–level or above that are related to agricultural technology and systems management.				
	One statistics course at the 400 level or above.				

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

To be considered for admission to the program, the applicant must have a Master of Science degree in agricultural technology and systems management or in a natural, biological, or physical science and should have a minimum of one year of calculus.

Requirements for the Doctor of Philosophy Degree in Agricultural Technology and Systems Management

The student must:

1. Complete a minimum of 30 credits in courses acceptable to the guidance committee, in addition to the credits earned in Agricultural Technology and Systems Management 999.
2. Complete at least one–half of the course credits to be counted toward the degree at Michigan State University.
3. Pass comprehensive examinations in the major field and in a secondary field.
4. Conduct original research upon a basic problem in the broad field of agricultural technology and systems management and prepare a dissertation of acceptable quality.

BIOSYSTEMS ENGINEERING

Biosystems engineering combines the knowledge of basic sciences (physics, chemistry, and biology), mathematics, engineering sciences, and engineering design to seek sustainable solutions to support life on this planet. Biosystems engineers are concerned with ensuring adequate food supply while efficiently utilizing the natural resources and preserving the environment. Specifically, biosystems engineers work in the areas of food production systems; food processing systems; management of natural resources including soil conservation, water management, and water quality; environment including pollution control and waste management; renewable energy resource systems; and many other exciting related areas.

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 available under both Plan A (with thesis) and Plan B (without thesis). The Plan A option is designed for students who plan to work in the research and development departments of private organizations or to pursue a Doctor of Philosophy degree in biosystems engineering. The Plan B option is designed for students who plan to work in industry and who want to acquire in–depth knowledge in an area of biosystems engineering.

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 pursue a master's program successfully without taking collateral courses. 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 in an accredited program in engineering or a Bachelor of Science degree in a science–oriented program. Applicants without a bachelor's degree in an accredited program in engineering must have completed:
   a. Four semesters of calculus at the college level.
   b. One semester of inorganic chemistry.
   c. Two semesters of physics.
   d. At least two engineering science courses, excluding laboratory courses.

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, they will be specified on the admission form. A grade of 2.0 or higher is required for each collateral course. 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 Professsional Engineers should consult with the Department of 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 included in a student's approved program of study, 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 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.[1,2,3]	
2. Both of the following courses:	
BE 820 Research Methods in Biosystems Engineering	1
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[3]	6
2. Complete two additional biosystems engineering courses at the 800–900 level *excluding* Biosystems Engineering 890.	
3. Pass a final oral examination over the written thesis administered by the department.	
4. 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:	
1. Complete one of the following courses:	
BE 831 Biosystems Analysis	3
BE 832 Network Design and Optimization of Biological Systems	3
BE 833 Artificial Neural Network Applications in Biological Systems	3
2. Complete three additional biosystems engineering courses at the 800–900 level *excluding* Biosystems Engineering 890.	
3. 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.	

[1] Not more than 4 credits of Biosystems Engineering 890 may be counted toward the requirements for the degree under Plan A.

[2] Not more than 6 credits of Biosystems Engineering 890 may be counted toward the requirements for the degree under Plan B.

[3] Not more than 8 credits of Biosystems Engineering 899 may be counted toward the requirements for the degree under Plan A.

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), MSU 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 program with a major in biosystems engineering is designed for persons who plan to conduct research in private and governmental organizations, or who plan to conduct research and teach in universities.

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, upon consideration of the likelihood that the applicant will be able to pursue a doctoral program successfully without taking collateral courses.

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. A grade of 2.0 or higher is required for each collateral course. 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 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 Agricultural Engineering and at least one member shall be from a department outside of the college. 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 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:

1. Complete a minimum of 54 credits beyond the master's degree distributed as follows:

	CREDITS
a. A minimum of 24 credits in Biosystems Engineering 999.	
b. A minimum of 30 additional credits in courses at the 400–, 800–, and 900–level including:[1,2]	
(1) A minimum of 15 credits in courses at the 800–900 level.	
(2) Both of the following courses:	
BE 820 Research Methods in Biosystems Engineering	1
BE 892 Biosystems Engineering Seminar	1
(3) Four additional biosystems engineering courses at the 800–900 level *excluding* Biosystems Engineering 890.	
(4) One 400–, 800, or 900–level course emphasizing statistics.[3]	

2. 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.
3. Pass the examination in defense of the dissertation. The examination may be retaken once.
4. 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.

[1] Not more than 6 credits of Biosystems Engineering 890 may be counted toward the requirements for the degree.

[2] Not more than 10 credits in transfer from another educational institution may be counted toward the requirements for the degree.

[3] This course may have been completed prior to enrollment in the doctoral program.

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 those courses the primary focus of which is 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 those courses the primary focus of which is independent study, the student may be enrolled on probational status in the doctoral degree program for one additional semester. If at the end of the additional semester the student has no more than three deferred grades, the student may continue to enroll in the doctoral degree program. If at the end of the additional semester the student still has more than three deferred grades, the student will be dismissed from the program.
   c. *Academic Progress and Professional Potential.* Each student's academic progress and professional potential are evaluated 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 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.

BUILDING CONSTRUCTION MANAGEMENT

The Master of Science degree program with a major in building 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 program is flexible and can accommodate the needs and interests of each student. Many of the courses are offered once a week in the evening.

The master's program in building 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 adviser 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 department.

Students who are enrolled in the master's program in building 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 building 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 building 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 with Applications I or its equivalent); 3 semester credits of introductory physics (PHY 231 Introductory Physics I or its equivalent); and 8 semester credits of business, management, or economics-related courses.

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:

BCM	124	Residential Construction Materials and Methods
BCM	210	Commercial Construction Methods

One or more of the following courses:

BCM	222	Statics and Strengths of Materials
BCM	315	Construction Quantity Surveying
BCM	322	Structural Systems
CSE	101	Computing Concepts and Competencies

Requirements for the Master of Science Degree in Building Construction Management[1,2,3]

The student must complete a total of 30 credits for the degree under either Plan A or Plan B. The student's program of study must be approved by the student's academic adviser and must meet the requirements specified below:

	CREDITS
Requirements for Both Plan A and Plan B	
1. A minimum of 18 credits in 800–900 level courses.	
2. Both of the following courses:	
BCM 817 Computer–Integrated Construction Management	3
BCM 892 Construction Management Research Seminar	2
3. Two additional Building Construction Management courses, excluding Building Construction Management 890, 898, and 899.[4]	
4. One graduate course in research methods.	
5. One graduate course in statistics.	
Additional Requirements for Plan A	
1. The following course:	
BCM 899 Master's Thesis Research[2]	6
Additional Requirements for Plan B	
1. The following course:	
BCM 898 Master's Research[3]	3

[1] No more than 6 credits in independent study courses, including Building Construction Management 890, may be counted toward the requirements for the degree.

[2] No more than 6 credits of Building Construction Management 899 may be counted toward the requirements for the degree.

[3] No more than 3 credits of Building Construction Management 898 may be counted toward the requirements for the degree.

[4] Students without a background in construction project scheduling must complete Building Construction Management 811 in partial fulfillment of this requirement.

Transfer Credits

No more than 6 semester credits of graduate course work (excluding research and thesis credits) may be transferred from other recognized educational institutions.

DEPARTMENT of ANIMAL SCIENCE

Maynard G. Hogberg, 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 career opportunities in animal agriculture. Graduates may be employed in marketing, agribusiness, finance, manufacturing, or public relations. They may hold positions as extension specialists, as salespersons of products from or for animal agriculture, or as advisers on farm management. They may be employed in animal breeding or commercial farming associations.

Scientific principles of biology and animal agriculture developed from various animal models are an important component of the animal sciences program. Another important component is the application of animal management procedures in agricultural operations.

The animal science major provides students much flexibility in meeting their program requirements. Students can benefit most from this flexibility with careful guidance from their academic advisers as they plan programs of study consistent with their interests and goals. Therefore, each student's academic adviser must approve the courses in which the student enrolls for a given semester.

All students in animal science must complete a set of required core courses involving the disciplines of breeding and genetics, nutrition, physiology, and management. These principles are taught utilizing beef cattle, dairy cattle, horses, poultry, sheep, and swine. Students must also complete the agribusiness management option, the science option, or the preveterinary option.

The agribusiness management option is designed to prepare students for careers in managing livestock operations. Marketing, sales, and production of livestock and livestock products offer numerous employment opportunities.

The science option is designed for students who are preparing for graduate study and careers in research and animal product development.

The preveterinary option is designed for students who are interested in careers in veterinary medicine working with food animals and horses. Some of the requirements for admission to the professional program in the College of Veterinary Medicine are included in the requirements for the option.

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: Agriculture and Natural Resources 489; Animal Science 313, 314, 315. Those courses are referenced in items 2. and 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:*			30
	ANS	110	Introductory Animal Agriculture	4
	ANS	210	Animal Products	4
	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:*[1]			3 or 4
	CEM	143	Survey of Organic Chemistry	4
	CEM	251	Organic Chemistry I	3
c.	*Two of the following species management courses:*			6
	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
d.	*One of the following three options:*			24 to 33

Agribusiness Management Option (24 credits):

(1) The requirements for the Specialization in Agribusiness Management as specified in the *Specialization in Agribusiness Management* statement in the *Department of Agricultural Economics* statement (18 credits).

(2) The following course (3 credits):

EC	201	Microeconomics	3

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

ANS	422	Advanced Beef Cattle Feedlot Management	3
ANS	432	Advanced Dairy Cattle Management	3
ANS	442	Advanced Horse Management	3
ANS	472	Advanced Swine Management	3

Preveterinary Option[1] (33 credits):

(1) All of the following courses (27 credits):

BCH	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
MTH	116	College Algebra and Trigonometry	5
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) At least 6 credits from the following Animal Science courses:

ANS	305	Applied Animal Behavior	3
ANS	320	Muscle Foods	3
ANS	404	Advanced Genetics of Farm Animals	2
ANS	405	Endocrinology of Reproduction	3
ANS	407	Food and Animal Toxicology	3
ANS	407L	Toxicology Methods Laboratory	2
ANS	413	Non-Ruminant Nutrition	4
ANS	414	Advanced Animal Breeding	2
ANS	415	Biology of Growth and Lactation	3
ANS	416	Meat Science and Muscle Biology	2
ANS	417	Topics in Toxicology	1
ANS	422	Advanced Beef Cattle Feedlot Management	3
ANS	425	Principles of Animal Biotechnology	3
ANS	427	Environmental Toxicology and Society	3
ANS	432	Advanced Dairy Cattle Management	3
ANS	442	Advanced Horse Management	3
ANS	445	Equine Exercise Physiology	4
ANS	455	Avian Physiology	4
ANS	472	Advanced Swine Management	3
ANS	483	Ruminant Nutrition	3

Science Option (24 credits):

(1) The following course (4 credits):

STT	201	Statistical Methods	4

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

BCH	200	Introduction to Biochemistry	4
BCH	401	Basic Biochemistry	4

(3) At least 16 credits from the following courses, including at least 6 credits in Animal Science courses:

ANS	305	Applied Animal Behavior	3
ANS	320	Muscle Foods	3
ANS	404	Advanced Genetics of Farm Animals	2
ANS	405	Endocrinology of Reproduction	3
ANS	407	Food and Animal Toxicology	3
ANS	407L	Toxicology Methods Laboratory	2
ANS	413	Non-Ruminant Nutrition	4
ANS	414	Advanced Animal Breeding	2
ANS	415	Biology of Growth and Lactation	3
ANS	416	Meat Science and Muscle Biology	2
ANS	417	Topics in Toxicology	1
ANS	425	Principles of Animal Biotechnology	3
ANS	427	Environmental Toxicology and Society	3
ANS	445	Equine Exercise Physiology	4
ANS	455	Avian Physiology	4
ANS	483	Ruminant Nutrition	3
BS	110	Organisms and Populations	4
CEM	161	Chemistry Laboratory I	1
CEM	252	Organic Chemistry II	3
CSE	101	Computing Concepts and Competencies[2]	3
CSE	131	Introduction to Technical Computing	3
MIC	205	Allied Health Microbiology	3
PHY	231	Introductory Physics I	3
PSL	250	Introductory Physiology	4
STT	464	Statistical Methods for Biologists I	4
STT	465	Statistical Methods for Biologists II	3
ZOL	313	Animal Behavior	3
ZOL	341	Fundamental Genetics	4

[1] A student who selects the **Preveterinary Option** is required to complete Chemistry 251 to satisfy requirement 3. B.

[2] Students who pass a waiver examination for Computer Science and Engineering 101 may *not* use Computer Science and Engineering 101 to satisfy the requirements for the **Science Option**.

GRADUATE STUDY

The Department of Animal Science offers Master of Science and Doctor of Philosophy degree programs in animal science and a Doctor of Philosophy degree program in animal science—environmental toxicology.

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 Multidepartmental Doctoral Programs in Environmental Toxicology in the Graduate Education section of this catalog.

DEPARTMENT of BOTANY and PLANT PATHOLOGY

Raymond Hammerschmidt, Acting Chairperson

The Department of Botany and Plant Pathology 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 plant breeding and genetics—botany and plant pathology 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 botany and plant pathology and a Doctor of Philosophy degree program with a major in botany and plant pathology—environmental toxicology through the College of Natural Science. For information about those programs, refer to the statement on the Department of Botany and Plant Pathology in the *College of Natural Science* section of this catalog.

The Department of Botany and Plant Pathology 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 Botany and Plant Pathology, 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 Botany and Plant Pathology 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 AND GENETICS–BOTANY AND PLANT PATHOLOGY

The Department of Botany and Plant Pathology offers Master of Science and Doctor of Philosophy degree programs in plant breeding and genetics–botany and plant pathology. The requirements for admission and the requirements for the degree are specified in the statement on *Interdepartmental Graduate Programs in Plant Breeding and Genetics.*

DEPARTMENT of CROP and SOIL SCIENCES

Taylor Johnston , Acting Chairperson

UNDERGRADUATE PROGRAMS

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 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 genetic engineering, 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 of three options: Crops and Soils, Turfgrass Management, or Advanced Study. Students may also complete a business cognate and/or a specialization in food systems economics and agribusiness management, and may qualify to teach agriscience in high school under a program of study cooperatively developed by the student's faculty adviser and the Department of Agriculture and Natural Resources Education and Communication Systems.

1. The Crops and Soils Option is designed to prepare agronomists. These scientists have career opportunities with agricultural businesses; as consultants; with government agencies such as departments of agriculture and/or natural resources, the Soil Conservation Service, and the Cooperative Extension Service; as pest management specialists and managers of grower organizations; with land appraisal firms; in agencies involving environmental issues; and in international agriculture.
2. The Turfgrass Management Option is designed to prepare scientists for the rapidly expanding area of urban agriculture. Graduates have career opportunities in the industries involved with management of lawns, athletic fields, golf courses, and park and grounds maintenance.
3. The Advanced Study Option is specifically designed for those students who plan to pursue graduate studies. Although students who complete the other three options may pursue graduate study, this option requires the completion of advanced levels of mathematics and the basic sciences such as chemistry, physics, and botany.

Students who are enrolled in the Bachelor of Science degree program with a major in crop and soil sciences 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 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 three courses as specified below:

   ***Option I: Crops and Soils*:** All of the following courses: Agriculture and Natural Resources 489; Crop and Soil Sciences 370 and 492. Those courses are referenced in items 2., 3. a., and 3. b. below.

   ***Option II: Turfgrass Management*:** All of the following courses: Agriculture and Natural Resources 489; Crop and Soil Sciences 332 and 492. Those courses are referenced in items 2., 3. a., and 3. b. below.

   ***Option III: Advanced Study*:** All of the following courses: Agriculture and Natural Resources 489; Crop and Soil Sciences 370 and 492. Those courses are referenced in items 2., 3. a., and 3. b. below.

   Students who are enrolled in 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: Botany and Plant Pathology 105 and 106 and Chemistry 141, 143, and 161. The completion of Botany and Plant Pathology 106 and Chemistry 161 satisfies the laboratory requirement. Botany and Plant Pathology 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 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*:			14
	BCH	200	Introduction to Biochemistry	4
	CEM	161	Chemistry Laboratory I	1
	CSS	110	Computer Applications in Agronomy	2
	CSS	210	Fundamentals of Soil and Landscape Science	3
	CSS	310	Soil Management and Environmental Impact	3
	CSS	492	Seminar	1
b.	*One of the following three options*:			49 to 61

Option I: Crops and Soils (50 to 55 credits):

(1) *All of the following courses* (24 credits):

BOT	105	Plant Biology	3
BOT	106	Plant Biology Laboratory	1
CEM	143	Survey of Organic Chemistry	4
CEM	151	General and Descriptive Chemistry	4
CSS	101	Introduction to Crop Science	3
CSS	350	Introduction to Plant Genetics	3
CSS	370	Agricultural Cropping Systems Management	3
CSS	402	Principles of Weed Science	3

(2) *Three of the following courses* (11 or 12 credits):

BOT	301	Introductory Plant Physiology	3
BOT	405	Introductory Plant Pathology	4
ENT	404	Insects: Success in Biodiversity	4
GLG	201	The Dynamic Earth	4

(3) Two courses from *one* of the following two concentrations, and three courses from the *other* concentration (15 to 19 credits):

Concentration 1: Soils

MIC	425	Microbial Ecology[1]	3
CSS	430	Soil Fertility and Chemistry	3
CSS	440	Soil Biophysics	3
CSS	470	Soil Resources	3
FOR	404	Forest and Agricultural Ecology[1,2]	4

Concentration 2: Crops

CSS	201	Forage Crops	3
CSS	380	Crop Physiology	3
CSS	406	Seed Production and Technology	3
CSS	441	Plant Breeding and Biotechnology	4
CSS	451	Cellular and Molecular Principles and Techniques for Plant Sciences	4
FOR	404	Forest and Agricultural Ecology[1,2]	4

Option II: Turfgrass Management (49 or 50 credits):

(1) *All of the following courses* (38 credits):

BOT	105	Plant Biology	3
BOT	106	Plant Biology Laboratory	1
CEM	141	General Chemistry	4
CEM	143	Survey of Organic Chemistry	4
CSS	232	Introduction to Turfgrass Management	3
CSS	262	Turfgrass Management Seminar	1
CSS	332	Advanced Turf Management	3
CSS	342	Turfgrass Soil Management	3
CSS	350	Introduction to Plant Genetics	3
CSS	362	Management of Turfgrass Pests	4
CSS	402	Principles of Weed Science	3
CSS	430	Soil Fertility and Chemistry	3
CSS	470	Soil Resources	3

(2) *Three of the following courses* (11 or 12 credits):

BOT	301	Introductory Plant Physiology	3
BOT	405	Introductory Plant Pathology	4
ENT	404	Insects: Success in Biodiversity	4
GLG	201	The Dynamic Earth	4

Option III: Advanced Study (60 or 61 credits):

(1) *All of the following courses* (36 credits):

BOT	105	Plant Biology	3
BOT	106	Plant Biology Laboratory	1
CEM	141	General Chemistry	4
CEM	143	Survey of Organic Chemistry	4
CEM	152	Principles of Chemistry	3
CEM	251	Organic Chemistry I	3
CSS	101	Introduction to Crop Science	3
CSS	350	Introduction to Plant Genetics	3
CSS	370	Agricultural Cropping Systems Management	3
CSS	402	Principles of Weed Science	3
MTH	124	Survey of Calculus with Applications I	3
MTH	126	Survey of Calculus with Applications II	3

(2) *Three of the following courses* (11 or 12 credits):

BOT	301	Introductory Plant Physiology	3
BOT	405	Introductory Plant Pathology	4
ENT	404	Insects: Success in Biodiversity	4
GLG	201	The Dynamic Earth	4

(3) Thirteen additional credits in Biochemistry, Chemistry, Crop and Soil Sciences, and Physics courses approved by the student's academic adviser.

[1] Only *one* of the following courses may be counted toward the requirements for **Option I: Crops and Soils**: Microbiology 425 *or* Forestry 404.

[2] Forestry 404 may be counted only *once* toward the requirements for **Option I: Crops and Soils**.

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: Agriculture and Natural Resources 489, 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
				78 to 80
a.	*All of the following courses* (64 credits):			
	ANR	489	Integrated Approaches to Agriculture and Natural Resources Problems (W)	3
	BCH	200	Introduction to Biochemistry	4
	BS	111	Cells and Molecules	3
	CE	280	Introduction to Environmental Engineering	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	2
	CSS	210	Fundamentals of Soil and Landscape Science	3
	CSS	310	Soil Management and Environmental Impact	3
	CSS	455	Pollutants in the Soil Environment	3
	CSS	470	Soil Resources	3
	CSS	492	Seminar	1
	EC	201	Introduction to Microeconomics	3
	ENT	442	Concepts of Biological Information Systems	3
	GLG	201	The Dynamic Earth	4
	GLG	411	Hydrogeology	4
	MIC	301	Introductory Microbiology	3
	MIC	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	Solid and Hazardous Waste Management	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) FW	465	Ecological Risk Assessment	3
	PHM	450	Introduction to Chemical Toxicology	3
	(4) RD	336	State Environmental Law	3
	RD	430	Law and Resources	3
	(5) CSS	110	Computer Applications in Agronomy[1]	2
	CSE	101	Computing Concepts and Competencies[1]	3

[1] 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.

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 and genetics—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 *Multidepartmental Doctoral Programs in Environmental Toxicology* in the *Graduate Education* section of this catalog.

PLANT BREEDING and GENETICS—CROP and SOIL SCIENCES

The Department of Crop and Soil Sciences offers Master of Science and Doctor of Philosophy degree programs in plant breeding and genetics–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 and Genetics.*

DEPARTMENT of ENTOMOLOGY

Edward J. Grafius, Chairperson

The Department of Entomology is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science. The College of Natural Science offers Master of Science and Doctor of Philosophy degree programs with majors in entomology and in entomology—urban studies. In addition, the College of Natural Science offers a Doctor of Philosophy degree program with a major in entomology—environmental toxicology. For additional information about the department and its graduate degree programs, refer to the statement on the *Department of Entomology* in the *College of Natural Science* section of this catalog.

DEPARTMENT of FISHERIES and WILDLIFE

Thomas Coon, Acting Chairperson

UNDERGRADUATE PROGRAMS

Majors in this department prepare for professional careers chiefly as fisheries and wildlife managers, biologists, naturalists, and applied ecologists. However, graduates may also pursue related career opportunities as conservation officers; private consultants; or administrators with federal, state, and private agencies and organizations concerned with environmental management.

The bachelor's degree program in fisheries and wildlife provides a strong base in both the foundational and applied sciences of natural resource management. In addition, the program is designed to develop understanding of the cultural, recreational, and economic values of biological resources. The department offers a core of courses required of all majors, and allows for development of individual interests through electives.

Students who complete the requirements for the fisheries and wildlife major and choose elective courses appropriately can satisfy requirements for certification as an associate fisheries scientist by the American Fisheries Society or for certification as an associate wildlife biologist by The Wildlife Society.

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. For additional information, refer to the *Specialization in Agricultural and Natural Resources Biotechnology* statement.

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 all of the following courses: Fisheries and Wildlife 410, 412, 414, and 434. Those courses are referenced in item 3. a. 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 that consists of the following courses: Biological Science 110 and Chemistry 141 and 161. The completion of Biological Science 110 and Chemistry 161 satisfies the laboratory requirement. Biological Science 110 and Chemistry 141 and 161 may be counted toward both the alternative track and the requirements for the major referenced in item 3. below.

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

   Certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate. The completion of Mathematics 116 satisfies the College's mathematics requirement.
3. The following requirements for the major:

				CREDITS
a.	*All of the following courses:*			59
	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
	CSS	210	Fundamentals of Soil and Landscape Science	3
	FW	100	Introduction to Fisheries and Wildlife	3
	FW	324	Wildlife Biometry	3
	FW	364	Ecosystem Processes	3
	FW	410	Upland Ecosystem Management	3
	FW	412	Wetland Ecosystem Management	3
	FW	414	Aquatic Ecosystem Management	3
	FW	424	Population Analysis and Management	4
	FW	434	Human Dimensions of Fisheries and Wildlife Management	3
	MTH	116	College Algebra and Trigonometry	5
	MTH	124	Survey of Calculus with Applications I	3
	PHY	231	Introductory Physics I	3
	ZOL	355	Ecology	3
	ZOL	355L	Ecology Laboratory	1
b.	*One of the following courses:*			3 or 4
	BOT	218	Plants of Michigan	3
	BOT	418	Plant Systematics	3
	BOT	423	Wetland Plants and Algae	4
	FOR	204	Forest Vegetation	4
c.	One of the following courses:			4
	ZOL	328	Comparative Anatomy and Biology of Vertebrates	4
	ZOL	341	Fundamental Genetics	4
	ZOL	483	Environmental Physiology	4
d.	One of the following courses:			3 or 4

ENT	422	Aquatic Entomology	3
FW	462	Ecology and Management of Invertebrates	4
FW	471	Ichthyology	4
ZOL	360	Biology of Birds	4
ZOL	361	Michigan Birds	4
ZOL	365	Biology of Mammals	4
ZOL	366	Biology of Great Lakes Mammals	4
ZOL	384	Biology of Amphibians and Reptiles	3

GRADUATE STUDY

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 - Detroit 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 resource economics. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Resource Economics*.

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 *Multidepartmental Doctoral Programs in Environmental Toxicology* in the *Graduate Education* section of this catalog.

DEPARTMENT of FOOD SCIENCE and HUMAN NUTRITION

Mark A. Uebersax, Chairperson

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

UNDERGRADUATE PROGRAMS

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

The department also offers Bachelor of Science degree programs with majors in dietetics and nutritional sciences through the College of Human Ecology. For information about those programs, refer to the statement on the *Department of Food Science and Human Nutrition* in the *College of Human Ecology* 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.

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 339, 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*:			46
	BE	329	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	229	Unit Operations in Food Processing	3
	FSC	339	Food Processing and Engineering Laboratory	2
	FSC	401	Food Chemistry	3
	FSC	402	Food Chemistry Laboratory	1
	FSC	440	Food Microbiology	3
	FSC	441	Food Microbiology Laboratory	2
	FSC	455	Food Analysis	3
	FSC	470	Integrated Approaches to Food Product Development	2
	HNF	311	Principles of Human Nutrition	3
	MTH	124	Survey of Calculus with Applications I	3
	MTH	126	Survey of Calculus with Applications II	3
	PHY	231	Introductory Physics I	3
b.	*One* of the following six concentrations:			26 to 30
	Food Biotechnology Concentration (28 or 29 credits):			
	(1) All of the following courses (22 credits):			
		BCH	401	Basic Biochemistry 4
		CEM	251	Organic Chemistry I 3
		CEM	252	Organic Chemistry II 3
		CSS	451	Cellular and Molecular Principles and Techniques for Plant Sciences 4
		MIC	205	Allied Health Microbiology 3

MIC 206 Allied Health Microbiology Laboratory 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) One of the following courses (3 credits):
FSC 405 Application of Biotechnology to Food Science. 3
HRT 486 Biotechnology in Agriculture: Applications and Ethical Issues 3

Food Business and Industry Concentration (27 credits):

(1) All of the following courses (21 credits):
ACC 230 Survey of Accounting Concepts. 3
BCH 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
MIC 205 Allied Health Microbiology 3
MIC 206 Allied Health Microbiology Laboratory 1
MSC 300 Managerial Marketing 3
STT 315 Introduction to Probability and Statistics for Business. 3

(2) Two of the following courses (6 credits):
FI 311 Financial Management[1] 3
FSM 320 Agribusiness and Food Sales (W) 3
FSM 335 Food Marketing Management. 3
FSM 412 Financial Management in the Food System[1]. 3
MSC 302 Consumer and Organizational Buyer Behavior 3

Food Chemistry Concentration (28 credits):

(1) All of the following courses (25 credits):
BCH 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 2
MIC 205 Allied Health Microbiology 3
MIC 206 Allied Health Microbiology Laboratory 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. 3
FSC 405 Application of Biotechnology to Food Science. 3

Food Packaging Concentration (30 credits):

(1) All of the following courses:
BCH 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
MIC 205 Allied Health Microbiology 3
MIC 206 Allied Health Microbiology Laboratory 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 Concentration (27 credits):

(1) All of the following courses (21 credits):
ANS 407 Food and Animal Toxicology 3
BCH 200 Introduction to Biochemistry 4
CEM 251 Organic Chemistry I 3
FSC 421 Food Laws and Regulations 3
MIC 301 Introductory Microbiology. 3
MIC 302 Introductory Microbiology Laboratory 1
STT 201 Statistical Methods 4

(2) Six credits from the following courses:
ANS 407L Toxicology Methods Laboratory 2
ANS 417 Topics in Toxicology. 1
FSC 405 Application of Biotechnology to Food Science. 3
MIC 425 Microbial Ecology. 3
MIC 431 Microbial Genetics. 3
MIC 445 Basic Biotechnology. 3
PHM 450 Introduction to Chemical Toxicology 3

Food Technology Concentration (29 credits):

(1) All of the following courses (23 credits):
BCH 200 Introduction to Biochemistry 4
CEM 143 Survey of Organic Chemistry 4
FSC 420 Quality Assurance 2
FSC 421 Food Laws and Regulations 3
HNF 410 Sensory Assessment of Foods 2
MIC 205 Allied Health Microbiology 3
MIC 206 Allied Health Microbiology Laboratory 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
FSC 433 Food Processing: Muscle Foods. 3
Or
ANS 320 Muscle Foods 3

[1] *Either* Finance 311 *or* Food Systems Economics and Management 412, but not both of those courses, may be used to satisfy requirement (2) for the **Food Business and Industry Concentration**.

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.	All of the following courses:		15
	CEM 141	General Chemistry 4	
	FSC 211	Principles of Food Science. 3	
	FSC 229	Unit Operations in Food Processing. 3	
	FSC 420	Quality Assurance. 2	
	FSC 421	Food Laws and Regulations 3	
2.	One of the following courses:		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	
3.	One of the following courses:		3 or 4
	STT 200	Statistical Methods 3	
	STT 201	Statistical Methods 4	
	STT 231	Statistics for Scientists 3	
	STT 315	Introduction to Probability and Statistics for Business. 3	
	STT 351	Probability and Statistics for Engineers 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 Human Ecology. 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 the College of Human Ecology. For information about those programs, refer

to the statement on the Department of Food Science and Human Nutrition in the *College of Human Ecology* section of this catalog. 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 and Doctor of Philosophy degree programs in the Department of Food Science and Human Nutrition may elect specializations in infant studies. For additional information, refer to the statement on *Interdepartmental Graduate Specializations in Infant Studies* 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 *Multidepartmental Doctoral Programs in Environmental Toxicology* 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 professional forestry and forest conservation leading to the Bachelor of Science degree with a major in forestry.

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

Forests, comprising about one–third of the land area of the United States, are an extremely valuable resource. Forests benefit society in many ways: They provide the resource base for essential forest products, forage, and wildlife habitat. They stabilize streamflow, reducing soil erosion, floods, and avalanches. Forests play a critical role in maintaining a proper carbon dioxide balance in the earth's atmosphere. They provide widespread opportunities for outdoor recreation.

Forestry is the science and art of managing the natural resources that occur on and in association with forest lands. 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 these be timber production, recreational opportunities, wildlife habitat, forage, water regulation, preservation for scientific studies and special uses, or combinations of these uses.

Students in this major meet the requirements for one of the following two options: Professional Forestry or Forest Conservation.

PROFESSIONAL FORESTRY. A professional forester is a land manager. In addition to conventional technical subject matter, such as dendrology, ecology, biometry, forest economics, and wood utilization, the professional forester must also have fundamental knowledge of the biological, physical, and social sciences and communication skills. These areas are included in the professional forestry option.

FOREST CONSERVATION. In contrast to the professional forestry option, the forest conservation option emphasizes conservation and forest ecology, although students also study the technical aspects of forest management. The option provides a strong scientific preparation for understanding natural resource issues. It emphasizes developing analytical and communication skills necessary to create a positive interchange of ideas between forestry professionals and nontechnical audiences. A wide variety of electives is available to students who are interested in specific areas within the natural resources.

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.

Michigan State University's undergraduate forestry program has been accredited by the Society of American Foresters. It is the oldest existing undergraduate forestry program in the United States.

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 Agriculture and Natural Resources 489 and either Forestry 410 or Forestry 464. Those courses are referenced in items 2. and 3. b. 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 Botany and Plant Pathology 105 and 106 combined.
   b. Chemistry 141, 143, and 161.

   The completion of Chemistry 161 and either Biological Science 110 or Botany and Plant Pathology 106 satisfies the laboratory requirement. Biological Science 110, or Botany and Plant Pathology 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:*			27
	CEM	141	General Chemistry	4
	CEM	143	Survey of Organic Chemistry	4
	CEM	161	Chemistry Laboratory I	1
	CSS	210	Fundamentals of Soil and Landscape Science	3
	EC	202	Introduction to Macroeconomics	3
	FOR	201	Tenets of Forestry	1
	FOR	204	Forest Vegetation	4
	FOR	207	Natural Resource Data Analysis	3
	FOR	404	Forest and Agricultural Ecology	4
b.	*One of the following two options:*			33 to 45
	Option I: Professional Forestry (45 credits):			
	(1) *All of the following courses* (42 credits):			
	BOT	105	Plant Biology	3
	BOT	106	Plant Biology Laboratory	1
	BOT	301	Introductory Plant Physiology	3
	ENT	407	Diseases and Insects of Forest and Shade Trees	4
	FOR	304	Wood Technology	4
	FOR	306	Forest Biometry	4
	FOR	406	Silviculture	4
	FOR	408	Forest Management	4
	FOR	420	Forestry Field Studies[1]	3
	FOR	464	Natural Resource Economics and Social Science (W)	3
	FOR	466	Natural Resources Planning and Policy	3
	FW	444	Conservation Biology	3
	PHY	231	Introductory Physics I	3
	(2) *One of the following courses* (3 credits):			
	MTH	124	Survey of Calculus with Applications I	3
	MTH	132	Calculus I	3
	Option II: Forest Conservation (32 to 35 credits):			
	(1) *All of the following courses* (20 credits):			
	BS	110	Organisms and Populations	4
	FOR	230	Communicating Forestry Issues	3
	FOR	310	Foundations of Forest Conservation	2
	FOR	410	Forest Conservation Thesis (W)	3
	MTH	116	College Algebra and Trigonometry	5
	ZOL	355	Ecology	3
	(2) *One course from each of the following two groups* (6 or 7 credits):			
	(a) BOT	407	Diseases and Insects of Forest and Shade Trees	4
	BOT	441	Plant Ecology	3
	FW	420	Stream Ecology	3
	FW	472	Limnology	3
	ZOL	360	Biology of Birds	4
	(b) FOR	450	Forestry in International Development	3
	FOR	464	Natural Resource Economics and Social Science (W)	3
	RD	430	Law and Resources	3
	(3) *Two of the following courses* (6 to 8 credits):			
	FOR	406	Silviculture	4
	FOR	408	Forest Management	4
	FOR	460	Arboriculture	3
	FOR	461	Urban Forestry	3
	FW	410	Upland Ecosystem Management	4
	FW	412	Wetland Ecosystem Management	3
	FW	444	Conservation Biology	3
	PRR	449	Management of Natural Resource Based Recreation	3

[1] Field work for this course is scheduled in Michigan forests for several consecutive days away from the campus during the first summer session.

GRADUATE STUDY

The Department of Forestry offers Master of Science and Doctor of Philosophy degree programs in forestry, forestry—urban studies, and plant breeding and genetics—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 or forestry—urban studies are eligible for the dual Juris Doctor (JD) program with Michigan State University - Detroit 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 adviser. 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 adviser.

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 *Multidepartmental Doctoral Programs in Environmental Toxicology* in the *Graduate Education* section of this catalog.

FORESTRY–URBAN STUDIES

The Department of Forestry offers interdepartmental Master of Science and Doctor of Philosophy degree programs in forestry–urban studies.

For the Master of Science degree, both Plan A (with thesis) and Plan B (without thesis) are available. A total of 30 credits is required for the Master of Science degree under Plan A, and a total of 36 credits is required for the Master of Science degree under Plan B.

To be admitted to a major in forestry–urban studies, students must meet the requirements for admission to the Master of Science or Doctor of Philosophy degree program with a major in forestry. They must also meet the requirements for admission as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies* in the *Graduate Education* section of this catalog.

Students who are admitted to a major in forestry–urban studies must meet the requirements for the major in forestry leading to the Master of Science or Doctor of Philosophy degree. They must also meet the requirements for the urban studies component of the program as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies.*

At least two members and the chairperson of the student's guidance committee must be faculty members in the Department of Forestry.

PLANT BREEDING and GENETICS—FORESTRY

The Department of Forestry offers Master of Science and Doctor of Philosophy degree programs in plant breeding and genetics–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 and Genetics.*

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

DEPARTMENT of HORTICULTURE

Wayne H. Loescher, Chairperson

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 (flowers), landscape horticulture (trees and shrubs), 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 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 science (economics, management, and marketing). Communication and computer skills are also cultivated within the horticulture curriculum. Students complete either the General Horticulture option or the Horticulture Landscape Design, Construction, and Management option. In both options, students obtain hands–on experiences through labo-

ratory 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 additional information, refer to the *Specialization in Agricultural and Natural Resources Biotechnology* statement.

Requirements for the Bachelor of Science Degree in Horticulture

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

   The University's Tier II writing requirement for the Horticulture major is met by completing Agriculture and Natural Resources 489 and Horticulture 404. Those courses are referenced in items 2. and 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: Botany and Plant Pathology 105 and 106 and Chemistry 141, 143, and 161. The completion of Botany and Plant Pathology 106 and Chemistry 161 satisfies the laboratory requirement. Botany and Plant Pathology 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 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
	ANR 493	Professional Internship in Agriculture and Natural Resources	3
	BOT 105	Plant Biology	3
	BOT 106	Plant Biology Laboratory	1
	CEM 141	General Chemistry	4
	CEM 143	Survey of Organic Chemistry	4
	CEM 161	Chemistry Laboratory I	1
	CSS 210	Fundamentals of Soil and Landscape Science	3
	HRT 203	Principles of Horticulture I	2
	HRT 203L	Principles of Horticulture I Laboratory	1
	HRT 204	Principles of Horticulture II	2
	HRT 204L	Principles of Horticulture II Laboratory	1
	HRT 404	Horticultural Management (W)	3
b.	*One of the following two options:*		35 to 39
	General Horticulture (35 or 36 credits):		
	(1) *All of the following courses* (17 credits):		
	BOT 301	Introductory Plant Physiology	3
	BOT 405	Introductory Plant Pathology	4
	CSS 350	Introduction to Plant Genetics	3
	ENT 404	General Entomology	4
	HRT 221	Greenhouse Structures and Management	3
	(2) *Three of the following horticultural production courses* (9 credits):		
	HRT 310	Nursery Management	3
	HRT 322	Greenhouse Production I: Potted Plants[1]	3
	HRT 323	Greenhouse Production II: Cut Flowers and Bedding Plants[1]	3
	HRT 331	Tree and Small Fruit Production and Management	3
	HRT 341	Vegetable Production and Management	3
	(3) *Three of the following courses* (9 or 10 credits):		
	CSS 451	Cellular and Molecular Principles and Techniques for Plant Sciences	4
	HRT 401	Physiology and Management of Herbaceous Plants	3
	HRT 403	Handling and Storage of Horticultural Crops	3
	HRT 480	Woody Plant Physiology	3
	HRT 486	Biotechnology in Agriculture: Applications and Ethical Issues	3
	Horticulture Landscape Design, Construction, and Management (39 credits):		
	(1) *All of the following courses*:		
	ATM 431	Irrigation, Drainage and Erosion Control Systems	3
	BOT 407	Diseases and Insects of Forest and Shade Trees	4
	CSS 232	Introduction to Turfgrass Management	3
	HRT 211	Ornamental Trees and Narrow–Leaved Evergreens	3
	HRT 212	Ornamental Flowering Shrubs and Broad–Leaved Evergreens	3
	HRT 310	Nursery Management	3
	HRT 311	Landscape Design and Management Specifications	4
	HRT 411	Landscape Contract Management	3
	LA 220	Graphic Communication	4
	LA 330	Site Construction: Materials and Methods	4
	MTH 116	College Algebra and Trigonometry	5

[1] Either Horticulture 322 or 323, but not both of those courses, may be used to satisfy this requirement.

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.

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 and GENETICS—HORTICULTURE

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

SCHOOL of PACKAGING

Bruce R. Harte, Director

UNDERGRADUATE PROGRAMS

The School of Packaging offers a program of instruction leading to the degree of Bachelor of Science. The program is designed to prepare graduates for purchasing, production, quality control, package development, research, sales, marketing, testing, or technical service positions. Such positions may lead to management responsibilities in production, marketing, distribution, quality control, and development.

Graduates may find employment in package user industries and in package supplier industries. Package user industries include most industrial, public, and transportation organizations, since some form of packaging is involved in the production and movement to market of nearly every item of consumption in today's economy. Package supplier industries include companies that print and convert paper and plastic flexible materials as well as manufacturers of such diverse items as bottles, cans, folding cartons, corrugated boxes, steel drums, and wooden pallets. In addition, graduates may serve as distributors and sales representatives whose primary functions are to represent manufacturers, design packaging, and to some extent warehouse packaging supplies for use by relatively small packagers. The packaging machinery industry is especially attractive to those graduates who are mechanically inclined and have ability in sales or technical service.

The program is flexible enough to provide highly individualized choices that allow every student to capitalize on his or her own skills and interests. Ample electives provide for a broad, general preparation or highly specialized study in considerable depth for such areas as food packaging, medical or pharmaceutical packaging, industrial packaging or other areas of specialization.

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 Agriculture and Natural Resources 489 and Packaging 485. Those courses are referenced in items 2. and 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 and Microbiology 105 or 205. The completion of Chemistry 143 and 161 satisfies the laboratory requirement. Chemistry 141, 143 and 161 and Microbiology 105 or 205 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	322	Packaging with Paper and Paperboard	4
	PKG	323	Packaging with Plastics	4
	PKG	410	Distribution Packaging Dynamics	3
	PKG	415	Packaging Decision Systems	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
	MIC	105	Microbes in Everyday Life	3
	MIC	205	Allied Health Microbiology	3
c.	*One of the following courses:*			3
	MTH	124	Survey of Calculus with Applications 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 Agriculture and Natural Resources 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 distribution packaging, environmental impact and recycling of packaging materials, human factors in packaging, and packaging systems development and optimization. Programs of study and research are flexible and are designed to meet the needs of individual students.

Master of Science

Emphasis is placed upon a broad education in packaging that includes 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 at least 16 credits in Packaging courses.
2. Demonstrate an understanding of basic statistics.

Additional Requirements for Plan A

1. At least three 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. At least four 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.	

DEPARTMENT of PARK, RECREATION and TOURISM RESOURCES

Joseph D. Fridgen, Chairperson

UNDERGRADUATE PROGRAM

The Department offers a Bachelor of Science degree in park, recreation and tourism resources. The program has been accredited by the National Recreation and Park Association (NRPA) with the American Association for Leisure and Recreation (AALR). By combining a body of specialized professional knowledge with the study of natural, social,

management, and behavioral sciences, the program provides an opportunity for the student to obtain a broad, interdisciplinary, liberal education and to emphasize one or more interdisciplinary professional areas. The park, recreation and tourism resources major is designed to prepare students for professional positions in park, recreation, tourism, and leisure services. Persons in such positions administer programs and manage facilities and resources designed to serve people's leisure needs and to enhance their quality of life.

Students in the Department of Park, Recreation and Tourism Resources must acquire an understanding of conceptual foundations of recreation and leisure, leisure service delivery systems, leadership and programming principles, leisure behavior, recreation needs of special populations, policy and administration, and principles and procedures for assessment, planning, and evaluation of park, recreation and tourism services. They also must acquire the ability to integrate theory with practice in the area of park, recreation, tourism, and leisure services. In addition to the professional program, students in the department complete at least one of the following interdisciplinary professional emphasis areas designed to provide additional breadth and depth:

Design and Development of Recreation Areas

This emphasis introduces students to park design and comprehensive recreation planning principles and techniques. Students in this emphasis supplement the basic core of courses in recreation with courses in urban planning, landscape architecture, economics, and related human and resource planning fields. The emphasis is designed to prepare students for entry–level positions in recreation or multiresource planning agencies and for graduate programs in planning and design. Graduates may ultimately apply their planning skills in executive level positions in both private and public sectors.

Natural Resource–Based Recreation Management

Federal, state, county, and municipal park systems offer a variety of career opportunities in resource management. Careers may also be found in the private and nonprofit service sectors managing both public and private lands for recreational purposes.

Resource managers are responsible for developing and managing recreational facilities such as campgrounds, trails and boating, and swimming sites. They work with wildlife biologists, landscape architects, historians, archaeologists, park interpreters, and others in the planning of sites and management of visitors to minimize environmental impacts and optimize recreational experiences. Graduates may assume middle and upper management positions in municipal, metropolitan, county, state, and national park systems.

Recreation Program Management

This emphasis is designed to prepare students for management opportunities in community, nonprofit agency, commercial, and institutional recreation. Students who elect this emphasis focus upon the needs of different population subgroups and the design and management of recreation programs to meet those needs. Graduates may become managers of municipal recreation departments, community centers, and community school programs. Students with an institutional interest may work within corporations or state departments of correction. Students with a community or nonprofit agency interest may work with YMCAs, YWCAs, Boy Scouts, Girl Scouts, children's camps, and churches. Students with a commercial interest may work within resorts, hotels, and travel organizations.

Therapeutic Recreation

The therapeutic recreation emphasis is designed to prepare students to deliver specific activity services that contribute to the adjustment or recovery of special populations. Courses in such subjects as psychology, anatomy, education, and social science supplement a sequence of courses in therapeutic recreation. Placement opportunities include mental health centers, rehabilitation facilities, extended care facilities, mental retardation facilities, and special school and community programs for handicappers, seniors, and other special needs groups. Students are advised to complete requirements leading toward National Council for Therapeutic Recreation Certification (NCTRC) and certification by other professional organizations.

Tourism and Commercial Recreation

Tourism and commercial recreation continue to be growth industries requiring managers who are skilled in recreation, marketing, and planning. This emphasis is designed to prepare students for careers in commercial recreation, natural resource–based tourism, and community–centered tourism. Students who are interested in commercial recreation may select courses related to starting or managing businesses such as marinas, natural resource–based resorts, or recreation lodging establishments. Students who are interested in tourism may select courses related to careers in state tourism marketing agencies, tourism consulting firms, visitor and convention bureaus, or natural resource management agencies, or in international commercial recreation and tourism.

Zoo and Aquarium Science

The operation of modern zoo and aquarium facilities requires an integrated, interdisciplinary team to address such areas as animal care and health, the management of species survival programs, fundraising, landscape and enclosure design, visitor management, and interpretation and education. Increasingly, a bachelor's degree is required for employment in zoos and aquaria. The zoo and aquarium science emphasis is designed to prepare students for careers in management and interpretive education within zoo and aquarium environments. Students in this emphasis complete courses in zoology and other departments, as well as courses in park, recreation and tourism resources.

Requirements for the Bachelor of Science Degree in Park, Recreation and Tourism Resources

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 Park, Recreation and Tourism Resources.

   The University's Tier II writing requirement for the Park, Recreation and Tourism Resources major is met by completing Agriculture and Natural Resources 489 and Park and Recreation Resources 351. Those courses are referenced in items 2. and 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:*			37 to 40
	CSE	101	Computing Concepts and Competencies[1]	3
	PRR	213	Introduction to Parks, Recreation, and Leisure	3
	PRR	215	Recreation Program Management	4

PRR 293 Field Work in Park and Recreation Resources . . . 1 to 4
PRR 320 Human Behavior in Park and Recreation Settings . . . 3
PRR 351 Recreation and Natural Resources Communication (W) . . . 3
PRR 370 Administration and Operation of Park and Recreation Systems . . . 3
PRR 371 Management of Park and Recreation Agencies and Organizations . . . 3
PRR 393 Professional Seminar . . . 1
PRR 443 Parks and Recreation Planning and Design Concepts . . . 4
PRR 475 Evaluation in Parks and Recreation . . . 3
PRR 485 Legal Aspects of Parks, Recreation, and Sport . . . 3
PRR 493 Professional Internship in Park, Recreation and Tourism Resources . . . 3

b. *One of the following courses*: . . . 3 or 4
FOR 206 Natural Resource Data Analysis . . . 3
PLS 201 Introduction to Methods of Political Analysis . . 4
PSY 295 Data Analysis in Psychological Research[2] . . . 3
STT 200 Statistical Methods . . . 3
STT 201 Statistical Methods . . . 4
STT 315 Introduction to Probability and Statistics for Business . . . 3

c. *One sociology or psychology course of at least 3 credits.*[2,3] . . . 3

d. *One of the following six emphases:*[3,4] . . . 10 to 30

Design and Development of Recreation Areas (10 credits)
(1) *At least three of the following courses*:
HRT 211 Ornamental Trees and Narrow–Leaved Evergreens . . . 3
LA 220 Graphic Communication . . . 4
LA 240 Applied Design Fundamentals . . . 4
STA 110 Drawing I . . . 3

Natural Resource–Based Recreation Management (15 credits):
(1) *Both of the following courses* (6 credits):
PRR 210 Our National Parks and Recreation Lands . 3
PRR 449 Management of Natural Resource Based Recreation . . . 3
(2) *At least three of the following courses* (9 credits):
FOR 202 Introduction to Forestry . . . 3
FOR 466 Natural Resources Planning and Policy . . . 3
FW 203 Resource Ecology . . . 3
FW 205 Principles of Fisheries and Wildlife Management . . . 3
PRR 451 Park Interpretive Services and Visitor Information Systems . . . 3
RD 201 Environmental and Natural Resources . . . 3
RD 430 Law and Resources . . . 3

Recreation Program Management (12 credits):
(1) *The following course* (3 credits):
PRR 362 Recreation for Special Populations . . . 3
(2) *At least three of the following courses* (9 credits):
MGT 310 Human Resource Management (W) . . . 3
PSY 255 Industrial and Organizational Psychology . . 3
SOC 241 Social Psychology . . . 3
SOC 375 Urban Sociology . . . 3
SOC 361 Contemporary Communities . . . 3

Therapeutic Recreation (24 credits):
(1) *All of the following courses*:
PES 216 Applied Human Anatomy . . . 3
PES 217 Applied Human Anatomy Laboratory . . . 1
PRR 362 Recreation for Special Populations . . . 3
PRR 467 Programming in Therapeutic Recreation . . . 3
PRR 468 Therapeutic Recreation Techniques . . . 3
PSL 250 Introductory Physiology . . . 4
PSY 101 Introductory Psychology . . . 4
PSY 280 Abnormal Psychology . . . 3

Tourism and Commercial Recreation (15 to 17 credits):
(1) *One of the following courses* (3 credits):
PRR 473 Commercial Recreation and Tourism Enterprises . . . 3
PRR 474 Community and Natural Resource Based Tourism . . . 3
(2) *At least four of the following courses* (12 to 14 credits):
ACC 230 Survey of Accounting Concepts . . . 3
ADV 205 Principles of Advertising . . . 4
ADV 227 Principles of Public Relations . . . 4
GBL 395 Law, Public Policy, and Business . . . 3
HB 200 Introduction to the Hospitality Industry . . . 3
HB 237 Management of Lodging Facilities . . . 3
HB 307 Organizational Behavior in the Hospitality Industry . . . 3
HB 475 Innovations in Hospitality Marketing . . . 3
MGT 310 Human Resources Management (W) . . . 3
MSC 300 Managerial Marketing . . . 3
UP 201 The Role of Planning in Urban and Regional Development . . . 3

Zoo and Aquarium Science (30 credits):
(1) All of the following courses (17 credits):
FW 484 Environmental Education . . . 3
PRR 451 Park Interpretive Services and Visitor Information Systems . . . 3
PRR 473 Commercial Recreation and Tourism Enterprises . . . 3
ZOL 313 Animal Behavior . . . 3
ZOL 369 Introduction to Zoo and Aquarium Science . 3
ZOL 489 Capstone: Seminar in Zoo and Aquarium Science . . . 2
(2) Thirteen additional credits in zoo and aquarium science from a list of approved courses available from the Department of Park, Recreation and Tourism Resources.

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

[2] Psychology 295 may be used to satisfy either requirement 3. b. *or* 3. c., but not both of those requirements.

[3] A 3–credit course in psychology or sociology that is used to satisfy requirement 3.d. may also be used to satisfy requirement 3.c.

[4] The student may complete an emphasis other than one of the ones referenced below to satisfy this requirement. Examples of other emphases are Park Law Enforcement and Park Interpretation and Visitor Information Service. *Both* the emphasis *and* the related courses must be approved by the student's academic adviser.

GRADUATE STUDY

The Department of Park, Recreation and Tourism Resources offers programs in Park, Recreation and Tourism Resources and in Park, Recreation and Tourism Resources–Urban Studies leading to Master of Science and Doctor of Philosophy degrees.

Students in the Master of Science or Doctor of Philosophy degree program in park, recreation and tourism resources or park, recreation and tourism resources-urban studies are eligible for the dual Juris Doctor (JD) program with Detroit College of Law/MSU.

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

PARK, RECREATION AND TOURISM RESOURCES

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 must hold a baccalaureate degree, have achieved a grade–point average of 3.00 *(B)* or better in their last two years of education, and submit their scores from the General Test of the Graduate Record Examination. Students with strong academic backgrounds in the natural, biological, management, or social sciences are normally qualified to pursue graduate programs. However, students with limited backgrounds in park, recreation and tourism resources will be required to complete collateral courses in this field in addition to the requirements for the master's degree.

Requirements for the Master of Science Degree in Park, Recreation and Tourism Resources

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.

Requirements for Plan A

CREDITS

1. One statistics course of at least 3 credits.
2. All of the following courses (14 to 16 credits):

PRR	815	Park and Recreation Program Services	3
PRR	841	Park and Recreation Administration and Policy	3
PRR	844	Research Methods in Recreation, Parks, and Tourism	3
PRR	892	Park and Recreation Resources Seminar	1
PRR	899	Master's Thesis Research	4 to 6

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

PRR	840	Recreation and Tourism Economics	3
PRR	848	The Law and Leisure Services	3
PRR	870	Park, Recreation and Natural Resources Marketing	3
PRR	874	Leisure, Travel and Tourism	3

4. Eight to 10 additional credits in courses approved by the student's academic adviser. The courses should be in a discipline related to park, recreation and tourism resources.

Requirements for Plan B

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

PRR	815	Park and Recreation Program Services	3
PRR	840	Recreation and Tourism Economics	3
PRR	841	Park and Recreation Administration and Policy	3
PRR	844	Research Methods in Recreation, Parks, and Tourism	3
PRR	879	Case Studies in Park and Recreation Resources	3
PRR	892	Park and Recreation Resources Seminar	1

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

PRR	848	The Law and Leisure Services	3
PRR	870	Park, Recreation and Natural Resources Marketing	3
PRR	874	Leisure, Tourism, and Travel	3

3. Eight additional credits in courses approved by the student's academic adviser. The courses should be in a discipline related to park, recreation and tourism resources.

Doctor of Philosophy

The doctoral program in the Department of Park, Recreation and Tourism Resources is designed for students who wish to acquire the knowledge and skills needed for teaching, theory development, and research related to the management and use of park, leisure, recreation, and tourism resources. The program reflects the interdisciplinary and applied nature of the recreation field with special emphasis on those forms of recreation and tourism that depend heavily on the human and natural resource base.

The doctoral program provides an opportunity for students to integrate and synthesize information from a broad range of natural, social, and management sciences and to apply this knowledge to tourism– and recreation–related problems. These problems relate to both the private and public functions of recreation and tourism and to both the supply and demand dimensions. The field encompasses individual leisure–time decision making as well as broad trends in leisure activities within social and economic subgroups of the population. Persons working in the field of park, recreation and tourism resources utilize techniques, theories, and models from other disciplines, such as psychology, sociology, economics, and wildlife management, and adapt them to their own needs.

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 or 30 graduate credits beyond the bachelor's degree are required for admission to the doctoral program in park, recreation and tourism resources. Persons who hold degrees in a wide range of disciplines are encouraged to apply for admission to the doctoral program. However, students with limited backgrounds in park, recreation and tourism resources will be required to complete collateral courses in this field in addition to the requirements for the doctoral degree.

Applications for admission will be reviewed by the departmental graduate committee. The evaluation will be based on the applicant's undergraduate and graduate academic records, study objectives, experience, letters of recommendation, and personal motivation. Each applicant must submit scores on the General Test of the Graduate Record Examination.

Requirements for the Doctor of Philosophy Degree in Park, Recreation and Tourism Resources

The student's study program must be developed in cooperation with and approved by the student's major professor and guidance committee. In addition to dissertation research credits, doctoral students in park, recreation and tourism resources are expected to complete a minimum of 36 credits beyond the master's degree including:

1. At least 12 credits in park, recreation and tourism resources courses.
2. At least 8 credits in statistics and advanced research methods.
3. At least 12 credits in a minor field from outside the department.

Doctoral students are required to take a written qualifying examination after the first year of coursework. The examination will cover two broad fields: (1) a general field with emphasis on the broad scope and nature of areas of study within park, recreation and tourism resources; (2) a field involving research and scholarly methods. After the completion of eighty percent of the coursework, each student will be required to complete a written comprehensive examination focused on the student's area of specialization and the application of research and scholarly methods.

The student must pass a final oral examination as specified under requirements for the degree by the College of Agriculture and Natural Resources.

PARK, RECREATION AND TOURISM RESOURCES—URBAN STUDIES

The Department of Park, Recreation and Tourism Resources offers interdepartmental Master of Science and Doctor of Philosophy degree programs in park, recreation and tourism resources–urban studies.

For the Master of Science degree, both Plan A (with thesis) and Plan B (without thesis) are available. A total of 30 credits is required for the degree under Plan A or Plan B.

To be admitted to a major in park, recreation and tourism resources–urban studies, students must meet the requirements for admission to the Master of Science or Doctor of Philosophy degree program with a major in park, recreation and tourism resources. They must also meet the requirements for admission as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies* in the *Graduate Education* section of this catalog.

Students who are admitted to a major in park, recreation and tourism resources–urban studies must meet the requirements for the major in park, recreation and tourism resources leading to the Master of Science or Doctor of Philosophy degree. They must also meet the requirements for the urban studies component of the program as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies.*

DEPARTMENT of RESOURCE DEVELOPMENT

Scott D. Witter, Chairperson

Resource development is a transdisciplinary, integrative department that focuses on the connections among natural, economic, and human resources for the purpose of understanding balanced and sustainable development while respecting the cultural context within which development takes place. The department's purpose is to educate scholars and practitioners to serve society by enhancing individual, group, organizational, and community capacity to improve the quality of life in both domestic and international settings.

UNDERGRADUATE PROGRAM

ENVIRONMENTAL STUDIES AND APPLICATIONS

The Department of Resource Development offers a Bachelor of Science degree program with a major in environmental studies and applications. The objective of the program is to educate a diverse cadre of practitioners who will work across disciplines and at many professional levels to bring knowledge to bear on problems associated with the human–environment interface.

The environmental studies and applications program is designed to produce professionals who have the ability to analyze and interpret divergent viewpoints and understand the needs and values of all people. The program is based in a global perspective. It recognizes the strengths in differences and emphasizes a commitment to multicultural and multiracial solutions to development problems.

The central focus of the environmental studies and applications program is the interaction between sociocultural factors and the environment. The program draws on the physical, biological, and social sciences; law; and the communication arts. Based on a core set of courses, each student selects one of three competency areas designed to help students cultivate the use of scientific methods and gain experience analyzing the human, social, and political implications of resource development and management issues. The three competency areas are environmental resource applications, community and organizational planning and management, and environmental data development and analysis.

The environmental studies and applications program is designed to prepare students for meaningful careers in government agencies, regional planning organizations, nongovernmental organizations, private consulting firms, and environmentally concerned industries, as well as prepare them for graduate study.

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

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 Applications.

   The University's Tier II writing requirement for the Environmental Studies and Applications major is met by completing Agriculture and Natural Resources 489 and Resource Development 300. Those courses are referenced in items 2. and 3. a. below.

   Students who are enrolled in the Environmental Studies and Applications major leading to the Bachelor of Science degree in the Department of Resource Development 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 143. The completion of Biological Science 110 and Chemistry 143 satisfies the laboratory requirement. Biological Science 110, Chemistry 141 and 143 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:*			34
	GLG	201	The Dynamic Earth	4
	RD	200	Issues and Applications in Resource Development	3
	RD	300	Environmental Communication and Conflict Management (W)	3
	RD	301	Federal and State Environmental Policy	3
	RD	302	Natural Resource Issues	3
	STT	200	Statistical Methods	3
	ZOL	355	Ecology	3
b.	One of the following courses:			2 or 3
	RD	495	Senior Seminar	2
	RD	499	Senior Thesis Research	3
	ANR	493	Professional Internship in Agriculture and Natural Resources	3
c.	One of the following three Competency Areas:			18 or 19
	Environmental Resource Applications			
	RD	320	Resource Management and Planning	3
	RD	324	Water Resource Development	3
	RD	326	Introduction to Waste Management	3
	RD	415	Introduction to Impact Assessment	4
	One course from each of the other two Competency Areas			6
	Community and Organizational Planning and Management			
	RD	313	Grantwriting and Fund Development	3
	RD	430	Law and Resources	3
	RD	440	The Resource Development Policy Process in Michigan	3
	RD	470	Theory and Practice in Community and Economic Development	3
	One course from each of the other two Competency Areas			6 or 7
	Environmental Data Development and Analysis			
	FOR	206	Natural Resource Data Analysis	3
	RD	314	Environmental Assessment of Land Uses	3
	RD	315	Applications of Survey Research	3
	RD	316	Land Use and Natural Resource Management	3
	One course from each of the other two Competency Areas			6 or 7
d.	Two focused elective courses supportive of the chosen competency area from an approved list of courses that is available from the department.			6

GRADUATE STUDY

The Department of Resource Development offers Master of Science and Doctor of Philosophy degree programs in resource development and in resource development—urban studies. The department also offers a Doctor of Philosophy degree program in resource development—environmental toxicology.

Students in the Master of Science degree program in resource development or resource development—urban studies are eligible for the dual Juris Doctor (JD) program with Michigan State University - Detroit College of Law.

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

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

RESOURCE DEVELOPMENT

Students are expected to take courses dealing with the principal areas of resource development and, in addition, may concentrate on one or more of the following areas of emphasis:

community and organizational resource development, natural resource planning and policy, environmental policy, and resource economics and policy.

Students of resource development will find, in addition to the courses in this department, strong supporting courses in the departments of Agricultural Economics; Agricultural Engineering; Anthropology; Civil and Environmental Engineering; Communication; Crop and Soil Sciences; Economics; Fisheries and Wildlife; Forestry; Geography; Geological Sciences; Park, Recreation and Tourism Resources; Political Science; Psychology; and Sociology, and in Urban Planning and Landscape Architecture.

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 must have completed the undergraduate courses required for the bachelor's degree at Michigan State University or at some other institution with comparable degree requirements. Students with strong academic backgrounds in the natural, physical, or social sciences are normally qualified to carry on graduate programs in resource development with a minimum of additional work. Collateral and prerequisite courses may be required to overcome deficiencies in individual student programs in addition to the requirements for the master's degree.

Requirements for the Master of Science Degree in Resource Development

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 student's program of study must be developed in cooperation with and approved by the student's major professor and must include the requirements specified below.

Requirements for Plan A and Plan B

1. Agricultural Economics 829.
2. Resource Development 801, 802, 803.
3. Statistics and Probability 421.
4. A minimum of 6 credits in Resource Development courses.
5. A minimum of 6 credits in courses outside the Department of Resource Development.

Additional Requirements for Plan A

1. At least 4 credits in Resource Development 899.

Additional Requirements for Plan B

1. At least 3 credits in Resource Development 898.

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

To be admitted to the Doctor of Philosophy degree program in resource development, a student must have a master's degree in resource development or a related field.

Requirements for the Doctor of Philosophy Degree in Resource Development[1]

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

1. Agricultural Economics 829.
2. Resource Development 801, 802.
3. Two of the following courses: Resource Development 824, 826, 836, 843.
4. At least three courses in research methods and statistics including:
   a. Resource Development 803.
   b. Statistics and Probability 421.
   c. At least one additional research methods or statistics course.
5. A minimum of 9 credits in Resource Development courses.
6. A minimum of 12 credits in courses outside the Department of Resource Development.

The student is required to pass written comprehensive examinations in general resource development, in a specialized area within resource development, and in a specialized area outside resource development, as well as an oral comprehensive examination that is administered after the student has passed all of the written comprehensive examinations.

The student must complete a dissertation on a topic specifically relevant to one or more of the specialized areas within resource development. The dissertation must be acceptable to the student's guidance committee.

[1] Students who have completed a master's degree in resource development or in a closely aligned field and who believe that they have completed one or more of the courses listed below, or equivalent courses, may request appropriate substitutions.

RESOURCE DEVELOPMENT—ENVIRONMENTAL TOXICOLOGY

Doctor of Philosophy

For information about the Doctor of Philosophy degree program in resource development—environmental toxicology, refer to the statement on *Multidepartmental Doctoral Programs in Environmental Toxicology* in the *Graduate Education* section of this catalog.

RESOURCE DEVELOPMENT—URBAN STUDIES

The Department of Resource Development offers interdepartmental Master of Science and Doctor of Philosophy degree programs in resource development–urban studies.

To be admitted to the major in resource development—urban studies, students must meet the requirements for admission to the Master of Science or Doctor of Philosophy degree program with a major in resource development. They must also meet the requirements for admission as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies* in the *Graduate Education* section of this catalog.

Master of Science

Both Plan A (with thesis) and Plan B (without thesis) are available to students who are admitted to the major in resource development–urban studies. A total of 37 credits is required for the degree under Plan A and a total of 36 credits is required for the degree under Plan B. Students must meet the requirements for the major in resource development leading to the Master of Science degree. They must also meet the requirements for the urban studies component of the program as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies.*

Doctor of Philosophy

Students who are admitted to the major in resource development–urban studies must meet the requirements for the major in resource development leading to the Doctor of Philosophy degree. They must also meet the requirements for the urban studies component of the program as specified in the statement on *Interdepartmental Graduate Programs in Urban Studies.*

INSTITUTE of AGRICULTURAL TECHNOLOGY

Robert Schutzki, Acting Director

Since 1894 Michigan State University has provided several programs for persons who do not choose to enroll in four–year programs. These programs provide intensified and highly practical training for the young farmer and for the agricultural industry employee. Instruction is by regular University staff. Prospective students must be high school graduates or have sufficient work experience in the industry in which they wish to apply for training. For additional information on any of the programs write to the Institute of Agricultural Technology, Michigan State University, East Lansing, Michigan 48824–1039.

PROGRAMS

Dairy Production

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 which 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 are made aware of the continuing changes in rural living which have a great influence on agriculture.

Livestock Production

This program is designed to provide an opportunity for specialization in the areas of beef, sheep, swine, and poultry. The program also provides the flexibility for combining two or more of the above areas to develop individualized programs of study. Many livestock program graduates return to the home farm. However, 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 farming. While the demands for success are great, the opportunities for success are limited only by a person's desires or imagination.

Horse Management

The horse management program emphasizes management and equine skills that will help to prepare students for positions in Michigan's growing horse industry. There are many opportunities for students in the saddle, pleasure and race horse industry, if they have the proper training in management and production techniques. Students have the opportunity to spend two academic terms on placement training, working with professionals in the horse industry.

Crop Production

Farming is a rapidly changing occupation which requires aggressive young people who have specialized training in modern scientific developments in agriculture. To be successful, young farmers must apply the most recent developments in farm finance, production, harvesting, and marketing of products. They must keep up to date with present research in such areas as crop hybrids, farm chemicals, and tillage practices, and be able to determine which practices are applicable to them.

Most graduates of the crop production program return to their home farms where they help with management decisions or acquire land of their own. However, outside of the home farm, positions are available as farm managers, extension agents, certified seed dealers, and farm employees.

Electrical Technology

There is a need for highly trained electricians in most rural areas of Michigan. Rural electrical contractors need electricians capable of planning complex wiring and solving difficult wiring problems. The wiring systems on farms today are complex, as are many of the farmstead equipment control systems. In some cases, equipment breakdowns must be repaired promptly to avoid devastating losses. Electricians serving agriculture must be knowledgeable both in electrical systems and agricultural systems.

The Electrical Technology program is a complete electrical apprenticeship program recognized by the State Electrical Administrative Board. Graduates of the electrical technology Program receive credit for two years of experience by completing only 18 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 and refrigeration; animal and human environment control; electrical estimating; and electrical business management.

Agricultural Industries

Elevator and farm supply firms are seeking aggressive young people with specialized training in agri–business to serve modern agriculture. More than 500 graduates of the program are working in feed, grain and farm–supply firms as managers; assistant managers; feed, grain and sales personnel; and key employees. Attractive starting salaries are offered, and advancement opportunities are excellent for those who prove themselves on the job. Initiative and ability determine how fast progress can be made to a management position.

Power equipment dealers are supplying farmers with big–capacity, high–speed, and precision–built tractors and farm equipment. Many of these dealers are meeting the needs of other customers by supplying light–construction, lawn and garden, and recreational equipment as well. Technical ability is needed to provide the pre–delivery and repair service required to keep this equipment operating efficiently, to manage inventories of repair parts, and to effectively sell the equipment and parts the customer needs. For this reason, the strong demand for trained personnel continues. A decision to train for a place on the dealership team can mean a technical level job with excellent pay and a chance for advancement with any of over 400 different employers in Michigan.

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 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 not ignored. Students are required to take such courses 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.

Turfgrass Management

Golf Course Emphasis
Sports and Commercial Turf Management Emphasis

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

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 have been available with excellent potential for advancement. Previous experience working on a golf course maintenance crew is expected.

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

Program offerings will be integrated with other areas in turfgrass and landscape and nursery. Course offerings will include technical, communication, math and business. Placement training opportunities will be offered students at many of the leading industrial businesses.

Admission

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

In programs in which far more applications are received from qualified students than there are spaces available, the Admissions Committee will consider academic records, 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 on the same basis as degree students at MSU.

Scholarships are provided by industry groups and individual business firms and are awarded to students who have demonstrated superior scholastic ability or an outstanding work record.

Veterans Education

The programs offered by the Institute of Agricultural Technology are approved by the Department of Veterans Affairs as Cooperative Veterans Training Programs. Under some Chapters of Title 38, U.S. Code, veterans may receive educational benefits. Veterans planning to enroll should contact the Veterans Certification Section of the Office of the Registrar to determine their eligibility.

MICHIGAN AGRICULTURAL EXPERIMENT STATION

James Ian Gray, Director

The research programs of the Michigan Agricultural Experiment Station help to keep Michigan agriculture, natural resources, and communities strong and competitive as part of MSU's land grant university responsibilities.

Based in the College of Agriculture and Natural Resources, the Experiment Station is a network of laboratories and field stations across the state. More than 320 scientists from 23 academic departments within five colleges conduct Experiment Station research.

The Experiment Station 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 safe ways to protect crops, livestock, forests, and other natural resources from pests, disease, and other hazards, and on natural resource management strategies that are sound environmentally and economically. Research also concentrates on human nutrition, housing, and community development.

On campus, Experiment Station research is conducted in laboratories, greenhouses, and experimental plots. The 14 off–campus field stations range from a tree research center in the Upper Peninsula to fruit and vegetable research farms in the southern–most counties of the state.

The Experiment Station was organized under the Hatch Act of 1887, although the University had been conducting agricultural research since it was founded in 1855. Funding comes from the state and federal governments, commodity associations, industries, foundations, and individuals.

MICHIGAN STATE UNIVERSITY EXTENSION

Arlene Leholm, Director

Michigan State University Extension helps people improve their lives through an educational process that applies knowledge to critical issues, needs and opportunities. Extension, an educational outreach arm of Michigan State University, has offices in all Michigan counties and a staff of more than 300 locally based Extension educators who help citizens access and use the knowledge resources of MSU. Campus–based faculty members in a growing number of departments and colleges share expertise derived from research and other scholarly activities to support local Extension programs. MSU Extension, established in 1914, is part of a national educational system based in the nation's land–grant universities, and jointly funded by the U.S. Department of Agriculture and state and local government.

Extension recently facilitated a comprehensive statewide issues identification process. As a result of this inquiry, Extension and MSU will focus special attention over the next 18 to 24 months on three areas: economic development, the environment, and children, youth and families.

Ongoing base programs in Extension are focused in three areas:

Agriculture and Natural Resources Programs

The complexities of Michigan's agriculture and natural resources demand an educational focus on these key areas. Programming in agricultural technology, management and effective marketing helps commercial farmers use modern technology and business management. Educational assistance in natural resource topics helps citizens and leaders manage the state's natural resources effectively. Michigan citizens must be kept up to date to decide issues of land use management, planning and zoning, and environmental quality.

Michigan State University agricultural programs are designed to help growers produce efficiently, 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.

Education in marketing emphasizes the movement of farm products from producer to consumer. Producers learn about efficient marketing; operators of agribusiness firms learn effective management, and consumers receive the latest market information. Marketing programs also deal with product development, pricing, establishing cooperatives, developing new marketing firms and roadside marketing. Quality control is a constant concern, and Extension helps by setting up grower groups and consumer marketing groups that tie agricultural knowledge to consumer needs.

The same knowledge and expertise available to commercial agriculture is offered also to small and part–time farmers in a context relevant to their special needs. In addition, Extension directs a strong program to assist home gardeners and landscapers.

Michigan's natural resources are vital to the state's economy and quality of life. Michigan's multibillion–dollar tourist industry heavily depends on the natural resource assets of the state. As population growth continues to multiply demands on land and water resources, private citizens and public officials must determine values and set priorities concerning resources with the knowledge that many of their decisions are irreversible. Extension programs in natural resources emphasize wise use and conservation of land 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.

Agriculture and Natural Resources programs also include group leadership training, farm policy awareness; development of skills in agricultural engineering, farm safety education and safe application of pesticides, solid and hazardous waste management, environmental stewardship, and natural resource management. All local programs are supported by campus–based specialists.

Economic and Community Development Programs

Michigan State University Extension's Community and Economic Development Program provides 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 particularly on issues related to business and community vitality, economic development, employment and income, growth and growth management, local government operations and inter–governmental cooperation, understanding, participation and decision making.

Current programs focus 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.

Program goals are to promote active and representative citizen participation so that community residents can meaningfully influence decisions that affect them; to engage community members in problem identification to improve understanding of the local situation; to 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 across the life cycle.

Children, Youth and Family Programs bring together the expertise of professionals in home economics, 4–H youth programs and the Expanded Food and Nutrition Education Pro-

gram 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—helps build effective coalitions to enable children, youths and families to develop their full potential as leaders and initiate positive change throughout their lives.

4–H Youth Development Michigan—4–H Youth Programs is the youth development division of Children, Youth and Family Programs. It 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 19. Well trained volunteers conduct active, 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.

Home Economics

Extension Home Economics 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.

The Home Economics Program offers informal lifelong learning. It tracks with families across the life span with emphasis on positive parenting, resource management, human development, health, housing, and foods and nutrition. The Expanded Food and Nutrition Education Program (EFNEP) reaches thousands of limited–resource families with young children.

INSTITUTE of INTERNATIONAL AGRICULTURE

Russell Freed, Acting 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 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 advisers 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.

CENTER for INTEGRATED PLANT SYSTEMS

The Center for Integrated Plant Systems is administered jointly by the College of Agriculture and Natural Resources and the College of Natural Science. It was built in 1968 with funds contributed by the National Institutes of Health, the U.S. Department of Agriculture, Michigan State University, and the Michigan Agricultural Experiment Station. It contains well–equipped laboratories in which 16 research leaders from departments in the colleges of Natural Science and of Agriculture and Natural Resources conduct basic and applied research in pests, pesticides, and pest management and their environmental impacts.

Fields being covered by the research leaders include: toxicology and metabolism of pesticides; the movement, impact, and fate of pesticides in the environment; side–effects arising from the biological magnification of pollutants; mode of action of herbicides, insecticides, and fungicides; chemistry of pesticidal compounds; and resistance to pest control strategies and the management of resistance. Increasing emphasis is being placed on alternative methods of pest control including biological control, bioactive natural products, and the utilization of biotechnology to produce safer means of pest management. Two major service facilities in the Center are the Analytical Laboratory and the Center for Electron Optics which provide support and training in the University.

The Center is responsible for programs in integrated pest management and pesticide applicator training.

Lecture–laboratory courses are given by the staff members of the Center on subjects such as environmental toxicology, weed control, pesticide analysis, plant research procedures, electron microscopy, insect physiology, and toxicology to about 140 graduate students each year. The research leaders provide training towards the master's and doctoral degrees for students wishing to carry out studies on the biology and physiology of pests; toxicology research on pesticides, their fate and impact in the environment and their role in pest control; the development of alternatives to chemical pesticides; and integrated pest management.

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 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 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 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.

CENTER for REMOTE SENSING

The Center for Remote Sensing is administered jointly by the colleges of Agriculture and Natural Resources, Engineering, Natural Science, and Social Science. The Center was established in 1980 to strengthen and support the utilization of geographic information systems technologies and of remote sensing in research, instruction, and extension programs of academic departments.

The Center promotes interdisciplinary research through the collaborative efforts of faculty investigators, graduate assistants, and students in 14 departments. Major areas of research include land and water use and change–detection studies, planned economic development, forest inventory, agricultural assessment, biological productivity, environmental monitoring, data base development for land resources planning and management, crop stress evaluation, and terrain analysis. The Center and the Institute of Water Research have formed the Land and Water Systems Partnership.

Professional staff are available for consultation and technical assistance to faculty members and students. The Center publishes technical reports and newsletters and sponsors seminars and short courses.