PURDUE UNIVERSITY

2013-2014

Agricultural and Biological Engineering Student Handbook

Agricultural Engineering

(For students beginning college career Fall 2013)

Student Services Coordinator 765-494-1172
Fax 765-496-1115
joinabe@ecn.purdue.edu
www.purdue.edu/abe

Purdue University

Agricultural & Biological Engineering

ABE Building

Student Academic Center, Room 201

June 2013

Contents

This handbook is a guide. Changes may have been made since this version was completed. Please see your advisor if you have questions. If you need to see an older version of the handbook, please contact Yvonne (room 201 or hardebey@purdue.edu).

Introduction

Welcome to Purdue University and the Department of Agricultural and Biological Engineering!

The Agricultural and Biological Engineering Department is dedicated to providing a stimulating, educational environment for *all* students. The faculty and staff in the Department are committed to assisting students toward enriching, rewarding, and professional experiences at Purdue.

This handbook has been prepared to help students understand the requirements for their major, give guidance for selecting various elective courses in order to achieve success in their academic careers at Purdue University, and also provide useful information about the academic aspects of the department.

The Department of Agricultural and Biological Engineering (ABE) at Purdue University applies engineering and management principles to agriculture, food, and biological systems. A college education in one of the programs of the Agricultural and Biological Engineering Department will prepare students for many exciting career opportunities in the diverse areas of production of food and other biological materials, processing systems, and management of land and water resources. A student can select from these programs: Agricultural Engineering [specializing in either Machine Systems Engineering (MSE) or Environmental and Natural Resources Engineering (ENRE)], or Biological Engineering. The ABE program exposes students to a broad range of engineering topics and include "hands-on" training. The Agricultural Engineering program will be explained in this handbook.

Employment opportunities for Agricultural Engineering graduates include: product engineering, design and test engineering for machinery and manufacturing industries, engineering for consulting firms and government agencies responsible for environmental conservation and quality, facilities design, safety engineering, engineering management, private consulting, teaching in colleges and universities, and research in industry and government.

The plan of study leads to a degree of Bachelor of Science in Agricultural Engineering (B.S.A.E.). They are administered by the College of Engineering and the College of Agriculture. Beginning students can apply for admission to the College of Engineering and complete the First-Year Engineering Program. An alternative for students with an interest in agricultural engineering is to apply to the Pre-Agricultural and Biological Engineering program in the College of Agriculture. Students with an Environmental and Natural Resources Engineering can obtain a minor in Environmental and Ecological Engineering (EEE). The department also offers graduate study leading to the degrees of Master of Science (M.S.) or Doctor of Philosophy (Ph.D.). We also offer a 5 year dual BS/MS degree in each of our areas in which you can apply at the end of your sophomore year.

According to the strategic plan of the department, published in January 1997, the mission of the department is:

> *"To prepare students, citizens, and industry for the future through innovative education and extension/outreach programs and the discovery of knowledge."*

Educational Objectives and Program Outcomes

With input from various constituency groups and students, the Department of Agricultural and Biological Engineering has established education goals and objectives for its various programs.

Educational Goal
Provide students with learning opportunities that prepare them for future challenges in food, agricultural and biological engineering through the application and discovery of knowledge.

Educational Objective
The educational objectives of the Agricultural and Biological Engineering Department's programs are to produce graduates who:

- Effectively practice Agricultural Engineering in the areas of Machine Systems and/or Environmental and Natural Resources.
- Have demonstrated proficiency in fundamental engineering skills and technical knowledge as well as in professional and personal skills appropriate for their profession.
- Are prepared for future challenges in Agricultural Engineering through the application and discovery of knowledge.
- Learn and grow as individuals, contribute to society, and attain maximum potential through lifelong learning.

To achieve the program educational objectives, the department will:

- Recruit, support, and retain competent faculty and staff.
- Provide facilities and equipment to create an atmosphere conducive to learning and discovery and to the application of knowledge.

Student Outcomes:
To prepare graduates to attain program education objectives.

Graduates of this program will demonstrate:

a. An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d. An ability to function on multi-disciplinary teams.
e. An ability to identify, formulate, and solve engineering problems
f. An understanding of professional and ethical responsibility.
g. An ability to communicate effectively.
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
i. A recognition of the need for, and an ability to engage in life-long learning.
j. A knowledge of contemporary issues.
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Student Academic Center

In response to the department's strategic goal to: *"Provide students with effective educational opportunities to learn and grow as individuals, contribute to society, and attain maximum potential through life-long learning,"* the Student Academic Center was established. The Center is located in room 201 of the ABE building. Some of the services provided by the Center are:

- assist students with course selection and registration
- assist students with schedule adjustments to develop an appropriate academic schedule each semester
- maintain an up-to-date copy of each student's academic record
- collect and disseminate information relative to all undergraduate activities such as registration procedures, changes in regulations, and new course offerings
- serve as a distribution center for information related to internships, employment, and scholarships
- arrange for interviews with potential employers
- direct students to the correct resource on specific problems that cannot be resolved at the Center.

Advising

In addition to the advising services offered by the Center, each student in the Department is assigned to a faculty advisor who has expertise in the student's area of interest. Normally the same academic advisor is retained until graduation. The advisor will counsel on the academic requirements of the major and serve as a resource to answer other academic concerns, and will assist the students to develop their career goals and objectives. It is also hoped that the advisor will become a friend, listener, and source of information concerning non-academic matters if the need arises.

Student Responsibilities

Any specific interests or concerns you have in the Agricultural and Biological Engineering Department should be discussed with your advisor and/or the Student Services Coordinator. ***Students have the responsibility of initiating and maintaining contact with their advisor for guidance.*** It is important to remember that it is the student who is ultimately responsible for making sure course requirements are complete. The student record sheet in this handbook should be kept up-to-date and checked periodically against the ones in the advisor's file and the permanent file in the Center.

Employment Support

Qualified students often find jobs prior to graduation. Notices of available positions received in the department are posted on the job placement bulletin board located in the hallway of the second floor between rooms 213 and 214 , email from our Placement Coordinator (if you are not receiving emails with placement information, contact the placement coordinator in ABE 201) or on our website at https://engineering.purdue.edu/ABE/index.html. These notices include full- and part-time positions, summer and internship opportunities. Many students find full-time employment with organizations that have employed them during previous summers/internships.

University Regulations

Purdue has policies regarding discrimination, scholastic deficiency (probation or being dropped), harassment, honor code, fees, grade appeals, hazing, insurance, computer copyrights, and many other student concerns. Please take time to look over the University Regulations Handbook.

Programs in the Department of Agricultural and Biological Engineering

Agricultural Systems Management (ASM)

Agricultural Systems Management prepares individuals to organize and manage technology-based businesses, with emphasis on planning and directing an industry or business project with responsibility for results. ASM students develop skills in communications, business management, computers, and the agriculture sciences, in addition to technical courses based in the Agricultural and Biological Engineering Department. National and international job opportunities include: manufacturing and processing operations; technical services and diagnostics; building and equipment systems; materials handling and process flow; technical product application and sales; product evaluation and education; and production agriculture.

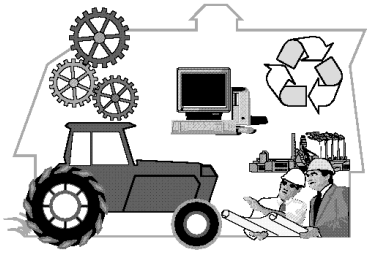
Agricultural Engineering (AE)

Agricultural engineers apply their knowledge of agricultural systems, natural resources, and engineering to equipment design and assure environmental compatibility of practices used by production agriculture. The Agricultural Engineering curriculum offers great breadth, with specialization choices in Machine Systems Engineering and Environmental and Natural Resources Engineering. Subject areas include computer-aided engineering, fluid power, finite element analysis, natural resource conservation, and engineering properties of biological materials. Excellent career opportunities exist in product engineering, equipment research and design, facilities design, environmental consulting, and engineering management.

Biological Engineering (BE)

The need for high quality, naturally derived biological products, such as foods, pharmaceuticals, and biochemicals has produced a high demand for knowledgeable, capable engineers who understand the complexity and sophistication of biological materials, combined with solid engineering skills. Employment and career advancement opportunities have been excellent for graduates, not only nationally, but also internationally. Graduates are successful in various positions in the biological and food process industry such as research development, process and product development, environmental and corporate engineering, and management.

Agricultural Engineering



Agricultural Engineering (AE) prepares engineers for careers in industries whose products are based upon biological materials or on applications for production agriculture. Agricultural engineers apply their knowledge of natural resource systems and engineering to equipment design and assure environmental compatibility of practices used by production agriculture. The AE curriculum offers great breadth, with specialization choices in machine systems engineering and environmental and natural resources engineering. The emphasis is on fundamental engineering sciences and design that may involve biological materials or the environment. Subject areas include computer-aided engineering, fluid power, finite element analysis, natural resource conservation, and engineering properties of biological materials. National and international careers include: product engineering, design and test engineers for equipment manufacturers, engineers with consulting firms and government agencies responsible for environmental quality, facilities design, safety engineering, forest engineering, and engineering management.

The AE program leads to a B.S. degree from the College of Engineering and is ABET accredited. Its unique strengths include: 1) career diversity, because your education includes the vital fundamentals that prepare engineers for a dynamic world; 2) the challenge of working with complex biological-based systems and on important problems; and 3) excellent salaries and work environments.

The curriculum's foundation is the Mathematical and Physical Sciences together with the Engineering science courses common to all Engineering curricula. Agricultural engineers then specialize by adding Biological Science courses and departmental courses including: engineering design, mobile hydraulics, soil and water conservation, finite element analysis, off-highway vehicle design, and sensors and controls. Students may choose a specific area of specialization. Hands-on laboratories and personal access to the most advanced engineering workstation computer network in the country bring the student's knowledge of advanced engineering tools to a practical level of utility.

In addition to an excellent technical education, agricultural engineers also learn communications, economics and professional ethics. The department's relatively small size provides a level of personal attention not usually available at a major university.

Also available is the 5 year dual BS/MS degree.

Areas of emphasis/specialization:

Machine Systems Engineering (MSE)

Environmental and Natural Resources Engineering (ENRE)

Emphasis Area: Machine Systems Engineering

The food and mobile equipment industries need engineers with a background in mechanical design, electronics, manufacturing and assembly processes, instrumentation and control, sensors, biology, and quality control. From creating intelligent machines that plant, cultivate, and harvest crops, to designing off-road vehicles and soil sensors, to developing precision farming technology, highly creative engineering is essential. Students will learn about analysis and design tools such as finite elements, CAD/CAM, solid modeling, and dynamic simulation. As a graduate of this curriculum, you will have excellent employment opportunities with a wide spectrum of manufacturers, consulting engineering firms, service industries and government agencies. For example, current graduates are developing new equipment, crop processing and handling machines, buildings and feed processing and handling equipment for animal agriculture, horticultural production facilities, construction and mining, forestry, lawn- and ground-care, and robotic applications in food and fiber production and processing. In addition, exciting engineering opportunities exist in electrohydraulic control laser sensors, global positioning systems, geographic information systems, environmentally safe recyclable vehicles, human operator comfort and remote vehicle control.

Free electives are chosen to fulfill an academic plan of study. Typically students take additional engineering, management or courses in which they have an interest. The basis of this Agricultural Engineering area of study provides machine systems engineers an education to enjoy their careers solving problems.

Design courses build individual confidence often involves problems submitted by engineers. Students also are familiar with group decision making and problem solving. We utilize alumni input to provide an education that has created a demand for our graduates.

Emphasis Area: Environmental and Natural Resources Engineering

Agricultural Engineering offers a unique perspective on environmental management that cannot be gained through other engineering or agricultural programs. Our training provides us with insight into the many issues and problems faced by food producers and those who protect the environment. As engineers we are uniquely trained to analyze problems, review options, and design site-specific solutions.

We deal with both point and non-point pollution sources. Point sources are contaminant releases that tend to be concentrated, easily recognizable, and located at a specific point. Examples include wastewater flowing from a pipe, a leaking underground fuel tank, odors from a livestock operation, and a pesticide spill. Such pollution sources are common to food production facilities and other manufacturers, including forest plantations and farming operations. These industries can have large waste management problems that require considerable engineering skill and ingenuity.

Nonpoint pollution tends to be less concentrated. It enters the environment over a considerably wider area and is responsible for many of agriculture's environmental impacts. Examples include soil erosion from fields leading to sedimentation problems in surface waterways, and surface runoff and leaching of nutrients, chemicals, and bacteria to the water system.

In environmental and natural resources engineering, you learn about the natural processes being affected - the water system, nitrogen cycle, biological systems and other ecosystems. You will also gain the background in chemistry and biology necessary to understand the influences of contaminants on the environment. Basic engineering principles are applied to avoid, reduce, and correct adverse environmental impacts on a wide variety of fronts including soil and plant environments, surface and ground water quality, air quality, animal environments, and food safety. Solution methods explored make use of some of

the newest technological approaches including finite element analysis, sensor design, geographical information systems, and global positioning systems.

This program prepares graduates for exciting careers in many different settings including:

- Federal, state, and local government agencies (Examples: bioremediation techniques to reduce river bank erosion; design practices to reduce stream bank erosion)
- Environmental engineering consulting firms (Examples: use a geographic information system to select the best site for a manure lagoon; run advanced hydrologic models to predict flooding for emergency planning)
- Food processing industries (Examples: develop cost effective methods of utilizing waste from a cheese processor; design a constructed wetland for waste processing from a food processor.)
- Agriculture industries (Examples: design waterways for drainage/irrigation water; on equipment for manure land application that produces less odor and is compatible with no-till farming practices. Many of our recent graduates have been hired by equipment firms looking at environmental and natural resources issues.)

Students choose engineering electives and other electives to complement required classes when in Environmental and Natural Resources Engineering.

Agricultural Engineering

https://ag.purdue.edu/oap/Pages/major.aspx

Credits	Course number	Course Title	Prerequisites	Credits	Course number	Course Title	Prerequisites
	Fall 1st Year				**Spring 1st Year**		
4	CHM 11500	General Chemistry	pre/co: calculus	4 or 3*	CHM 11600 or CS 15900	General Chemistry or Programing Applications for Engineers	CHM 11500
4	ENGL 10600	English Composition		3	COM 11400	Fundamentals of Speech Communication	
2	ENGR 13100	Tranforming Ideas to Innovation I		3	ENGR 13200	Transforing Ideas to Innovation II	ENGR 13100
4	MA 16500	Plane Analytic Geometry and Calculus I	ALEKS 75+	4	MA 16600	Plane Analytic Geometry and Calculus II	MA 16500
3	_ _ _ _ _ _ _	UCC Approved Humanities Selective		3	PHYS 17200	Modern Mechanics	MA 16500
17				**16**			

	Fall 2nd Year				**Spring 2nd Year**		
3	ABE 20500	Computation for Engineering Systems	ENGR 13200	3	ABE 21000	Thermodynamics Priciples of Engineering and Biological	CHM 11500, PHYS 17200
1	ABE 29000	Sophomore Seminar		4	MA 26200	Linear Algebra and Differential Equations	MA 26100
4	MA 26100	Multivariate Calculus	MA 16600	3	ME 27400	Basic Mechanics II	ME 27000
3	ME 27000	Basic Mechanics I	PHYS 17200	3	NUCL 27300	Mechanics of Materials	ME 27000
3	PHYS 24100	Electricity and Optics	PHYS 17200	4	_ _ _ _ _ _ _	Biological Science Selective	
3	_ _ _ _ _ _ _	Economics Selective					
17				**17**			

	Fall 3rd Year				**Spring 3rd Year**		
3	ABE 30500	Physical Properties of Biological Materials	ABE 20500	3	ABE 31400	Design of Electronic Systems	MA 26200
4	ABE 32500	Soil and Water Resource Engineering	pre/co: AGRY 25500, CE 34000	3	ABE 32000	Solid Modeling, Simulation and Analysis	MA 26200, NUCL 27300
3	AGRY 25500	Soil Science	CHM 11600	3	ABE 33000	Design of Machine Components	ABE 20500
4	CE 34000 and CE 34300 or ME 30900	Hydraulics and Elementary Hydraulics Lab or Fluid Mechanics	ME 27400	4	_ _ _ _ _ _ _	Biological Science Selective	
3	_ _ _ _ _ _ _	Agricultural Selective		3	_ _ _ _ _ _ _	Humanities or Social Science Selective	
17				**16**			

	Fall 4th Year				**Spring 4th Year**		
3	ABE 43500	Hydraulic Control Systems for Mobile Equipment	NUCL 27300	3	ABE 48600	Agricultural Engineering Design	ABE 48400
3	ABE 45000	Finite Element Method in Design and Optimization	ABE 32500 or ABE 33000	3	_ _ _ _ _ _ _	Engineering Technical selective	
1	ABE 48400	Project Planning and Management		2	_ _ _ _ _ _ _	Humanities or Social Science Selective	
1	ABE 49000	Professional Practice in Agricultural and Biological Engineering	ABE 29000	3	_ _ _ _ _ _ _	Humanities or Social Science Selective (300+ level)	
3	_ _ _ _ _ _ _	Engineering Technical selective		2 or 3*	_ _ _ _ _ _ _	Elective	
3	_ _ _ _ _ _ _	Written and Oral Communication Selective					
14				**14**			

128 semester credits required for Bachelor of Science degree.
2.0 GPa required for Bachelor of Science degree.

Official and complete prerequisite lists are in the course catalog; the incomplete listing presented here regards this program and course sequencing.

*The higher credit option within Chemistry/Programming course choices reduces Elective credit requirements.

Agricultural Engineering

https://ag.purdue.edu/oap/Pages/major.aspx

128 credits required for graduation

	Credits	Course number	Course Title
Departmental/Program Major Courses (126 or 125 credits)			
	Required Major Courses (34 credits)		
_____	3	ABE 20500	Computation for Engineering Systems
_____	3	ABE 21000	Thermodynamics Principles of Engineering and Biological Systems
_____	1	ABE 29000	Sophmore Seminar
_____	3	ABE 30500	Physical Properties of Biological Materials
_____	3	ABE 31400	Design of Electronic systems
_____	4	ABE 32500	Soil and Water Resource Engineering
_____	3	ABE 32000	Solid Modeling, Simulation and Analysis
_____	3	ABE 33000	Design of Machine Components
_____	3	ABE 43500	Hydraulic Control Systems for Mobile Equipment
_____	3	ABE 45000	Finite Element Method in Design and Optimization
_____	1	ABE 48400	Project Planning and Management
_____	3	ABE 48600	Agricultural Engineering Design
_____	1	ABE 49000	Professional Practice in Agricultural and Biological Engineering
	Other Departmental /Program Course Requirements (92 or 91 credits) (See Advising Resources)		
_____	2	ENGR 13100	Tranforming Ideas to Innovation I
_____	4	_ _ _ _ _ _ _	Biological Science Selective
_____	4	_ _ _ _ _ _ _	Biological Science Selective (satisfies Science #1 for core)
_____	4 or 3	CHM 11500	General Chemistry (satisfies Science #2 for core)
_____	4	CHM 11600 or CS 15900	General Chemistry or Programming Applications for Engineers
_____	4	MA 16500	Plane Analytic Geometry and Calculus I (satisfies Quantitative Reasoning for core)
_____	4	MA 16600	Plane Analytic Geometry and Calculus II
_____	4	MA 26100	Multivariate Calculus
_____	4	MA 26200	Linear Algebra and Differential Equations
_____	4	PHYS 17200	Modern Mechanics
_____	4	ENGL 10600	English Composition (satisfies Written Communication for core) (satisfies Information Literacy Selective for core)
_____	3	COM 11400	Fundamentals of Speech Communication (satisfies Oral Communication for core)
_____	3	_ _ _ _ _ _ _	Written and Oral Communication Selective
_____	3	_ _ _ _ _ _ _	Economics Selective (satisfies Human Culture Behavioral/Social Science for core)
_____	3	_ _ _ _ _ _ _	UCC Humanities Selective (satisfies Human Cultures Humanities for core)
_____	2	_ _ _ _ _ _ _	Humanities or Social Science Selective
_____	3	_ _ _ _ _ _ _	Humanities or Social Science Selective
_____	3	_ _ _ _ _ _ _	Humanities or Social Science Selective (300+ level)
_____	3	AGRY 25500	Soil Science
_____	2	ENGR 13200	Tranforming Ideas to Innovation II
_____	3	ME 27000	Basic Mechanics I
_____	3	ME 27400	Basic Mechanics II
_____	3	NUCL 27300	Mechanics of Materials
_____	3	PHYS 24100	Electricity and Optics
_____	4	(CE 34000 and CE 34300) or ME 30900	(Hydraulics and Elementary Hydraulics Lab) or Fluid Mechanics
_____	3	_ _ _ _ _ _ _	Agricultural Selective
_____	6	_ _ _ _ _ _ _	Engineering Technical Selective
Electives (2 or 3 credits)			
_____	2 or 3	_ _ _ _ _ _ _	Elective

University Core Requirements:

Human Cultures Humanities:	_____	*Science, Technology, and Society:*	_____
Human Cultures Behavioral/Social Science:	_____	*Written Communication:*	_____
Information Literacy:	_____	*Oral Communication:*	_____
Science #1:	_____	*Quantitative Reasoning:*	_____
Science #2:	_____		

128 semester credits required for Bachelor of Science degree.
2.0 GPa required for Bachelor of Science degree.

Environmental and Natural Resources Engineering

https://ag.purdue.edu/oap/Pages/major.aspx

Credits	Course number	Course Title	Prerequisites	Credits	Course number	Course Title	Prerequisites
	Fall 1st Year				**Spring 1st Year**		
4	CHM 11500	General Chemistry	pre/co: calculus	4	CHM 11600	General Chemistry	CHM 11500
4	ENGL 10600	First-Year Composition		3	COM 11400	Fundamentals of Speech Communication	
2	ENGR 13100	Tranforming Ideas to Innovation I		2	ENGR 13200	Transforming Ideas to Innovation II	ENGR 13100
4	MA 16500	Plane Analytic Geometry and Calculus I	ALEKS 75+	4	MA 16600	Plane Analytic Geometry and Calculus II	MA 16500
3	_ _ _ _ _ _ _	UCC ApprovedHumanities Selective		4	PHYS 17200	Modern Mechanics	MA 16500
17				**17**			

	Fall 2nd Year				**Spring 2nd Year**		
3	ABE 20500	Computation for Engineering Systems	ENGR 13200	3	ABE 21000	Thermodynamics Principles of Engineering and Biological Systems	CHM 11500, PHYS 17200
1	ABE 29000	Sophmore Seminar		4	MA 26200	Linear Algebra and Differential Equations	MA 26100
4	MA 26100	Multivariate Calculus	MA 16600	3	ME 27400	Basic Mechanics II	ME 27000
3	ME 27000	Basic Mechanics I	PHYS 17200	3	NUCL 27300	Mechanics of Materials	ME 27000
3	PHYS 24100	Electricity and Optics	PHYS 17200	4	_ _ _ _ _ _ _	Biological science selective	
3	_ _ _ _ _ _ _	Economics selective					
17				**17**			

	Fall 3rd Year				**Spring 3rd Year**		
3	ABE 30500	Physical Properties of Biological Materials	ABE 20500	3	ABE 31400	Design of Electronic systems	MA 26200
4	ABE 32500	Soil and Water Resource Engineering	pre/co: AGRY 25500, CE 34000	3	ABE 33000	Design of Machine Components	ABE 20500.
3	AGRY 25500	Soil Science	CHM 11600	3	_ _ _ _ _ _ _	ENRE Engineering Selective	
4	(CE 34000 and CE 34300) or ME 30900	Hydraulics and Elementary Hydraulics Lab or Fluid Mechanics	ME 27400	4	_ _ _ _ _ _ _	Biological Science selective	
3	_ _ _ _ _ _ _	Humanities or Social Science selective		3	_ _ _ _ _ _ _	Agricultural selective	
17				**16**			

	Fall 4th Year				**Spring 4th Year**		
3	ABE 45000	Finite Element Method in Design and Optimization	NUCL 27300	3	ABE 48600	Agricultural Engineering Design	ABE 48400
1	ABE 48400	Project Planning and Management	ABE 32500 or ABE 33000	3	_ _ _ _ _ _ _	Engineering technical selective	
1	ABE 49000	Professional Practice in Agricultural and Biological Engineering	ABE 29000	2	_ _ _ _ _ _ _	Humanities or social selective	
3	_ _ _ _ _ _ _	ENRE Technical selective		3	_ _ _ _ _ _ _	Humanities or social selective (30000+)	
3	_ _ _ _ _ _ _	Engineering technical selective		2	_ _ _ _ _ _ _	Elective	
3	_ _ _ _ _ _ _	Written or oral communication selective					
14				**13**			

128 semester credits required for Bachelor of Science degree.
2.0 GPa required for Bachelor of Science degree.

Environmental and Natural Resource Engineering

https://ag.purdue.edu/oap/Pages/major.aspx 128 credits required for graduation

	Credits	Course number	Course Title
Departmental/Program Major Courses (126 credits)			
Required Major Courses (28 credits)			
_____	3	ABE 20500	Computation for Engineering Systems
_____	3	ABE 21000	Thermodynamics Principles of Engineering and Biological Systems
_____	1	ABE 29000	Sophmore Seminar
_____	3	ABE 30500	Physical Properties of Biological Materials
_____	3	ABE 31400	Design of Electronic systems
_____	4	ABE 32500	Soil and Water Resource Engineering
_____	3	ABE 33000	Design of Machine Components
_____	3	ABE 45000	Finite Element Method in Design and Optimization
_____	1	ABE 48400	Project Planning and Management
_____	3	ABE 48600	Agricultural Engineering Design
_____	1	ABE 49000	Professional Practice in Agricultural and Biological Engineering
Other Departmental /Program Course Requirements (98 credits) (See Advising Resources)			
_____	2	ENGR 13100	Tranforming Ideas to Innovation I
_____	4	_ _ _ _ _ _ _	Biological Science Selective
_____	4	_ _ _ _ _ _ _	Biological Science Selective
_____	4	CHM 11500	General Chemistry (satisfies Science #1 for core)
_____	4	CHM 11600	General Chemistry (satisfies Science #2 for core)
_____	4	MA 16500	Plane Analytic Geometry and Calculus I (satifies Quantitative Reasoning for core)
_____	4	MA 16600	Plane Analytic Geometry and Calculus II
_____	4	MA 26100	Multivariate Calculus
_____	4	MA 26200	Linear Algebra and Differential Equations
_____	4	PHYS 17200	Modern Mechanics
_____	4	ENGL 10600	First-Year Composition (satisfies Written Communication for core) (satisfies Information Literacy Selective for core)
_____	3	COM 11400	Fundamentals of Speech Communication (satisfies Oral Communication for core)
_____	3	_ _ _ _ _ _ _	Communications Selective
_____	3	_ _ _ _ _ _ _	Economics Selective (satisfies Human Culture Behavioral/Social Science for core)
_____	3	_ _ _ _ _ _ _	UCC Humanities Selective (satisfies Human Cultures Humanities for core)
_____	2	_ _ _ _ _ _ _	Humanities or Social Science Selective
_____	3	_ _ _ _ _ _ _	Humanities or Social Science Selective
_____	3	_ _ _ _ _ _ _	Humanities or Social Science Selective (30000+ level)
_____	3	AGRY 25500	Soil Science
_____	2	ENGR 13200	Tranforming Ideas to Innovation II
_____	3	ME 27000	Basic Mechanics I
_____	3	ME 27400	Basic Mechanics II
_____	3	NUCL 27300	Mechanics of Materials
_____	3	PHYS 24100	Electricity and Optics
_____	4	(CE 34000 and CE 34300) or ME 30900	(Hydraulics and Elementary Hydraulics Lab) or Fluid Mechanics
_____	3	_ _ _ _ _ _ _	Agricultural Selective
_____	3	_ _ _ _ _ _ _	ENRE Engineering Selective
_____	3	_ _ _ _ _ _ _	ENRE Technical Selective
_____	6	_ _ _ _ _ _ _	Engineering Technical Selective
Electives (2 credits)			
_____	2	_ _ _ _ _ _ _	Elective

University Core Requirements:

Human Cultures Humanities:	_____	*Science, Technology, and Society:*	_____
Human Cultures Behavioral/Social Science:	_____	*Written Communication:*	_____
Information Literacy:	_____	*Oral Communication:*	_____
Science #1:	_____	*Quantitative Reasoning:*	_____
Science #2:	_____		

128 semester credits required for Bachelor of Science degree.
2.0 GPa required for Bachelor of Science degree.

Machine Systems / Environmental & Natural Resources Required Courses

Required Courses (Catalog Descriptions)

ABE 20500 Engineering Computations for Engineering Systems. Credit Hours: 3.00. Development of engineering problem solving and design skills. Use of Excel, Matlab, and MathCad for problem solving, data analysis, numerical modeling, and statistics. Introduction to elementary statics, dynamics, materials, thermodynamics, fluid mechanics, and energy topics. Typically offered Fall. Prerequisites: (Undergraduate level ENGR 12600 Minimum Grade of D- or Undergraduate level ENGR 12100 Minimum Grade of D- or Undergraduate level ENGR 13200 Minimum Grade of D- or Undergraduate level ENGR 19500 Minimum Grade of D-) and Undergraduate level PHYS 17200 Minimum Grade of D- [may be taken concurrently].

ABE 21000 Biological Applications of Material and Energy Balances. Credit Hours: 3.00. Applications of material and energy balances to biological and engineering systems; development of a framework for the analysis of biological systems from an engineering perspective. Introduction to applications of the first and second laws of thermodynamics to biological and mechanical engineering systems. Topics include refrigeration systems, power cycles, energy conversion systems, and environmental impacts of energy production. Typically offered Spring. Prerequisites: (Undergraduate level CHM 11500 Minimum Grade of D- or Undergraduate level CHM 10900 Minimum Grade of D- or Undergraduate level CHM 12300 Minimum Grade of D- or Undergraduate level CHM 12500 Minimum Grade of D- or Undergraduate level CHM 13500 Minimum Grade of D-) and Undergraduate level PHYS 17200 Minimum Grade of D- or (Undergraduate level PHYS 16200 Minimum Grade of D- and Undergraduate level PHYS 16300 Minimum Grade of D-).

ABE 29000 Sophomore Seminar. Credit Hours: 1.00. Current agricultural and biological engineering issues will be discussed by students, staff, and guest speakers. Career planning, employment opportunities, professionalism, ethics, and improvement of communication skills will be emphasized. Typically offered Fall.

ABE 30500 Physical Properties of Biological Materials. Credit Hours: 3.00. Physical properties of agricultural crops and food products and their relationship to harvesting, storage, and processing. Physical properties covered include: density, shape, moisture content, water potential, water activity, friction and flow or particulate solids, terminal velocity, thermal properties, interaction with electromagnetic radiation, and viscoelastic behavior of solids. Typically offered Fall. Prerequisites: Undergraduate level ABE 20500 Minimum Grade of D- [may be taken concurrently].

ABE 31400 Design of Electronic Systems. Credit Hours: 3.00. Fundamental aspects of circuits, microprocessors, transducers, sensors, instrumentation, and data acquisition are presented, with particular emphasis on electronic systems used in agricultural, biological, and food applications. Laboratory exercises used to apply the course material to constructing and testing circuits, microprocessor controlled systems, and the data collection and monitoring of systems. Typically offered Spring. Prerequisites: Undergraduate level MA 26200 Minimum Grade of D- or Undergraduate level MA 26600 Minimum Grade of D-

ABE 32000 Solid Modeling, Simulation and Analysis. Credit Hours: 3.00. Introduction to parametric, feature-based solid modeling; dimensioned 2D and 3D engineering drawings; tolerancing; mechanical dynamic simulation; kinematic models, analysis and simulation of simple linkages and complex systems; mechanism design and evaluation; visualization and animation of results; interfacing of computer aided engineering software. Projects involving industrial parts and assemblies will be discussed and assigned. Typically offered Spring. Prerequisites: (Undergraduate level MA 26200 Minimum Grade of D- or Undergraduate level MA 27200 Minimum Grade of D-) and (Undergraduate level NUCL 27300 Minimum Grade of D- or Undergraduate level AAE 20400 Minimum Grade of D-) and (Undergraduate level ME 27400 Minimum Grade of D- [may be taken concurrently] or Undergraduate level ME 27500 Minimum Grade of D- [may be taken concurrently] or Undergraduate level ME 29800 Minimum Grade of D- [may be taken concurrently])

ABE 32500 Soil and Water Resource Engineering. Credit Hours: 4.00. Interrelationships of the plant-water-air-

soil system; hydrologic processes; protection of surface and ground water quality; GIS targeting of soil and water protection measures; and design of subsurface and overland drainage systems, irrigation systems, and soil erosion control practices. Typically offered Fall. Prerequisites: (Undergraduate level AGRY 25500 Minimum Grade of D- [may be taken concurrently] or Undergraduate level NRES 25500 Minimum Grade of D- [may be taken concurrently]) and (Undergraduate level ME 30900 Minimum Grade of D- [may be taken concurrently] or (Undergraduate level CE 34000 Minimum Grade of D- [may be taken concurrently] and Undergraduate level CE 34300 Minimum Grade of D- [may be taken concurrently])).

ABE 33000 Design of Machine Components. Credit Hours: 3.00. Introduction to design; stress analysis; deformation and stiffness considerations; static and fatigue strength design; design of components of the food processing, farm and off-highway machines, and mechanical systems. Typically offered Spring. Prerequisites: (Undergraduate level NUCL 27300 Minimum Grade of D- or Undergraduate level AAE 20400 Minimum Grade of D-) and Undergraduate level ABE 20500 Minimum Grade of D- [may be taken concurrently].

ABE 43500 Hydraulic Control Systems for Mobile Equipment. Credit Hours: 3.00. Design of basic fluid power components and systems. Includes power steering, hydrostatic and hydromechanical transmission, electrohydraulic servovalves, servomechanism, and manually controlled systems. Typically offered Fall. Prerequisites: Undergraduate level CE 34000 Minimum Grade of D- and Undergraduate level CE 34300 Minimum Grade of D- or Undergraduate level ME 30900 Minimum Grade of D-.

ABE 45000 Finite Element Method in Design and Optimization. Credit Hours: 3.00. Fundamentals of the finite element method as it is used in modeling, analysis, and design of thermal/fluid and mechanical systems; one- and two-dimensional elements; boundary value problems, heat transfer and fluid flow problems; structural and solid mechanics problems involving beam, truss, plate and shell elements; computer-aided design and optimization of machine components, structural elements and thermal/fluid system. Typically offered Fall. Prerequisites: (Undergraduate level MA 26600 Minimum Grade of D- or Undergraduate level MA 36600 Minimum Grade of D- or Undergraduate level MA 30300 Minimum Grade of D- or Undergraduate level MA 30400 Minimum Grade of D- or Undergraduate level MA 26200 Minimum Grade of D-) and (Undergraduate level BME 20400 Minimum Grade of D- or (Undergraduate level NUCL 27300 Minimum Grade of D-) or Undergraduate level AAE 20400 Minimum Grade of D-).

ABE 48400 Project Planning and Management. Credit Hours: 1.00. Review of topics relevant to project planning and execution in industry, including technical communication, budgeting, team management, intellectual property rights, contracts and timelines. Students will select a Capstone project proposal within a team environment. Typically offered Fall. Prerequisites: ABE 32500 and ABE 33000.

ABE 48600 Agricultural Engineering Design. Credit Hours: 3.00. Equipment or system design projects, team or individual, related to contemporary or potential problems in agricultural engineering. Typically offered Spring. Prerequisites: Undergraduate level ABE 48400 Minimum Grade of D- .

ABE 49000 Professional Practice in Agricultural and Biological Engineering. Credit Hours: 1.00. Career areas in agricultural engineering; job opportunities and graduate study; professional attitudes and ethics; contracts and specifications; patents. Typically offered Fall. Prerequisites: Undergraduate level ABE 29000 Minimum Grade of D-.

AGRY 25500 Soil Science. Credit Hours: 3.00. (NRES 25500) Differences in soils; soils genesis; physical, chemical, and biological properties of soils; relation of soils to problems of land use and pollution; soil management relative to tillage, erosion, drainage, moisture supply, temperature, aeration, fertility, and plant nutrition. Introduction to fertilizer chemistry and use. Not available to students who have taken AGRY 27000. Typically offered Fall Spring. Prerequisites: Undergraduate level CHM 11200 Minimum Grade of D- or Undergraduate level CHM 11600 Minimum Grade of D- or Undergraduate level CHM 12600 Minimum Grade of D- or Undergraduate level CHM 12400 Minimum Grade of D- or Undergraduate level CHM 11000 Minimum Grade of D- or Undergraduate level CHM 13600 Minimum Grade of D- or (Undergraduate level CHEM C1020 Minimum Grade of D- and Undergraduate level CHEM C1220 Minimum Grade of D-) or (Undergraduate level CHEM C1060 Minimum Grade of D- and Undergraduate level CHEM C1260 Minimum Grade of D-).

CE 34000 Hydraulics. Credit Hours: 3.00. Fluid properties; hydrostatics; kinematics and dynamics of fluid

flows; conservation of mass, energy, and momentum; flows in pipes and open channels. Formal laboratory experiments. Typically offered Summer Fall Spring. Prerequisites: Undergraduate level CE 29800 Minimum Grade of C- or Undergraduate level ME 25100 Minimum Grade of C- or Undergraduate level AAE 23000 Minimum Grade of C- or Undergraduate level CE 25100 Minimum Grade of C- or Undergraduate level ME 27400 Minimum Grade of C- or Undergraduate level ME 27500 Minimum Grade of C-. ***AND***

CE 34300 Elementary Hydraulics Laboratory. Credit Hours: 1.00. The laboratory covers basic concepts in analysis of experimental data and methods in hydraulic measurements. A variety of simple laboratory experiments illustrating the principles of hydraulics are performed. Typically offered Summer Fall Spring. Prerequisites: Undergraduate level CE 34000 Minimum Grade of C- [may be taken concurrently]. ***OR ME 30900***

CHM 11500 General Chemistry. Credit Hours: 4.00. Stoichiometry; atomic structure; periodic properties; ionic and covalent bonding; molecular geometry; gases, liquids, and solids; crystal structure; thermochemistry; descriptive chemistry of metals and non-metals. Required of students majoring in science and students in engineering who are not in CHM 12300. One year of high school chemistry or one semester of college chemistry required. Typically offered Fall Spring Summer. Prerequisites: Undergraduate level MA 15900 Minimum Grade of D- or Undergraduate level MA 15400 Minimum Grade of D- or Undergraduate level MA 16100 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 16500 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 22300 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 23100 Minimum Grade of D- [may be taken concurrently].

CHM 11600 General Chemistry. Credit Hours: 4.00. A continuation of CHM 11500. Solutions; quantitative equilibria in aqueous solution; introductory thermodynamics; oxidation-reduction and electrochemistry; chemical kinetics; qualitative analysis; further descriptive chemistry of metals and nonmetals. Typically offered Fall Spring Summer. Prerequisites: Undergraduate level CHM 11200 Minimum Grade of B or Undergraduate level CHM 11500 Minimum Grade of D- or Undergraduate level CHM 12500 Minimum Grade of D- or Undergraduate level CHM 10900 Minimum Grade of D- or Undergraduate level CHM 12300 Minimum Grade of D- or Undergraduate level CHM 13500 Minimum Grade of D- or (Undergraduate level CHEM C1050 Minimum Grade of D- and Undergraduate level CHEM C1250 Minimum Grade of D-) or (Undergraduate level CHEM C1010 Minimum Grade of D- and Undergraduate level CHEM C1210 Minimum Grade of D-).

COM 11400 Fundamentals of Speech Communication. Credit Hours: 3.00. A study of communication theories as applied to speech; practical communicative experiences ranging from interpersonal communication and small group process through problem identification and solution in discussion to informative and persuasive speaking in standard speaker-audience situations. Typically offered Fall Spring Summer.

CS 15900 Programming Applications for Engineers. Credit Hours: 3.00. Fundamental principles, concepts, and methods of programming (C and MATLAB), with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; fundamental algorithms and data structures; and use of programming logic in solving engineering problems. Students are expected to complete assignments in a collaborative learning environment. Typically offered Summer Fall Spring. Prerequisites: Undergraduate level ENGR 11600 Minimum Grade of D- [may be taken concurrently] or Undergraduate level ENGR 12600 Minimum Grade of D- [may be taken concurrently] or Undergraduate level ENGR 13100 Minimum Grade of D- [may be taken concurrently].

ENGL 10600 First-Year Composition. Credit Hours: 4.00. Extensive practice in writing clear and effective prose. Instruction in organization, audience, style, and research-based writing. Typically offered Fall Spring Summer.

ENGR 13100 Transforming Ideas To Innovation I. Credit Hours: 2.00. A partnership between Schools and Programs within the College of Engineering, introduces students to the engineering professions using multidisciplinary, societally relevant content. Developing engineering approaches to systems, generating and exploring creative ideas, and use of quantitative methods to support design decisions. Explicit model-development activities (engineering eliciting activities, EEAs) engage students in innovative thinking across the engineering disciplines at Purdue. Experiencing the process of design and analysis in engineering including how to work effectively in teams. Developing skills in project management, engineering fundamentals, oral and graphical communication, logical thinking, and modern engineering tools (e.g., Excel and MATLAB). Typically offered

Fall Spring Summer.

ENGR 13200 Transforming Ideas To Innovation II. Credit Hours: 2.00. A partnership between Schools and Programs within the College of Engineering continues building on the foundation developed in ENGR 13100. Students take a more in depth and holistic approach to integrating multiple disciplines perspectives while constructing innovative engineering solutions to open-ended problems. Extending skills in project management engineering fundamentals, oral and graphical communication, logical thinking, team work, and modern engineering tools (e.g., Excel and MATLAB). Typically offered Fall Spring Summer. Prerequisites: Undergraduate level ENGR 13100 Minimum Grade of C-.

MA 16500 Analytic Geometry and Calculus I. Credit Hours: 4.00. Introduction to differential and integral calculus of one variable, with applications. Conic sections. Designed for students who have had at least a one-semester calculus course in high school, with a grade of "A" or "B", but are not qualified to enter MA 16200 or 16600, or the advanced placement courses MA 17300 or 27100, or the honors calculus course MA 18100. Demonstrated competence in college algebra and trigonometry. Typically offered Fall Spring.

MA 16600 Analytic Geometry and Calculus II. Credit Hours: 4.00. Continuation of MA 16500. Vectors in two and three dimensions. Techniques of integration, infinite series, polar coordinates, surfaces in three dimensions. Not open to students with credit in MA 16200. Typically offered Fall Spring. Prerequisites: Undergraduate level MA 16500 Minimum Grade of C- or Undergraduate level MA 16100 Minimum Grade of C- or Undergraduate level MA 16300 Minimum Grade of C- or Undergraduate level MA 16700 Minimum Grade of C- or (Undergraduate level MA 22100 Minimum Grade of C- and Undergraduate level MA 22200 Minimum Grade of C-) or (Undergraduate level MA 22300 Minimum Grade of C- and Undergraduate level MA 22400 Minimum Grade of C-).

MA 26100 Multivariate Calculus. Credit Hours: 4.00. Planes, lines, and curves in three dimensions. Differential calculus of several variables; multiple integrals. Introduction to vector calculus. Not open to students with credit in MA 17400 or 27100. Typically offered Fall Spring Summer. Prerequisites: Undergraduate level MA 16200 Minimum Grade of D- or Undergraduate level MA 16600 Minimum Grade of D- or Undergraduate level MA 17300 Minimum Grade of D- or Undergraduate level MA 18100 Minimum Grade of D- or Undergraduate level MATH 16400 Minimum Grade of D- or Undergraduate level MA 17100 Minimum Grade of D- or Undergraduate level MA 16400 Minimum Grade of D- or Undergraduate level MATH M2160 Minimum Grade of D- or Undergraduate level MA 16900 Minimum Grade of D-.

MA 26200 Linear Algebra and Differential Equations. Credit Hours: 4.00. Linear algebra, elements of differential equations. Not open to students with credit in MA 26500 or 26600. Typically offered Fall Spring Summer. Prerequisites: Undergraduate level MA 26100 Minimum Grade of D- or Undergraduate level MA 18200 Minimum Grade of D- or Undergraduate level MA 17400 Minimum Grade of D- or Undergraduate level MA 27100 Minimum Grade of D- or Undergraduate level MATH 26100 Minimum Grade of D- or Undergraduate level MA 17200 Minimum Grade of D- or Undergraduate level MA 26300 Minimum Grade of D-

ME 27000 Basic Mechanics I. Credit Hours: 3.00. (CE 27100) Vector operations, forces and couples, free body diagrams, equilibrium of a particle and of rigid bodies. Friction. Distributed forces. Centers of gravity and centroids. Applications from structural and machine elements, such as bars, trusses, and friction devices. Kinematics and equations of motion of a particle for rectilinear and curvilinear motion. Typically offered Fall Spring Summer. Prerequisites: Undergraduate level PHYS 17200 Minimum Grade of D- and (Undergraduate level MA 16200 Minimum Grade of D- or Undergraduate level MA 16600 Minimum Grade of D- or Undergraduate level MA 18100 Minimum Grade of D-) and (Undergraduate level MA 26100 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 26300 Minimum Grade of D- [may be taken concurrently]) and Undergraduate level ENGR 13200 Minimum Grade of D- [may be taken concurrently].

ME 27400 Basic Mechanics II. Credit Hours: 3.00. Review and extension of particle motion to include energy and momentum principles. Planar kinematics of rigid bodies. Kinetics for planar motion of rigid bodies, including equations of motion and principles of energy and momentum. Three-dimensional kinematics and kinetics of rigid bodies. Linear vibrations, with emphasis on single-degree-of-freedom systems. Typically offered Fall Spring

Summer. Prerequisites: (Undergraduate level ME 27000 Minimum Grade of D- or Undergraduate level CE 27100 Minimum Grade of D-) and Undergraduate level ENGR 13200 Minimum Grade of D- and (Undergraduate level MA 26200 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 26600 Minimum Grade of D- [may be taken concurrently]).

ME 30900 Fluid Mechanics. Credit Hours: 4.00. Continuum, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Euler and Bernoulli equations, viscous flows, boundary layers, flow in channels and around submerged bodies, one-dimensional gas dynamics, turbomachinery. Typically offered Fall Spring. Prerequisites: Undergraduate level ME 26300 Minimum Grade of D- and (Undergraduate level ME 27400 Minimum Grade of D- or Undergraduate level CE 29800 Minimum Grade of D- or Undergraduate level ME 27500 Minimum Grade of D-) and (Undergraduate level MA 26200 Minimum Grade of D- or Undergraduate level MA 27200 Minimum Grade of D-) or (Undergraduate level MA 26500 Minimum Grade of D- and Undergraduate level MA 26600 Minimum Grade of D-) or (Undergraduate level MA 35000 Minimum Grade of D- and Undergraduate level MA 36000 Minimum Grade of D-). ***OR CE 34000 and CE 34300***

NUCL 27300 Mechanics of Materials. Credit Hours: 3.00. Analysis of stress and strain; equations of equilibrium and compatibility; stress-strain laws; extension, torsion, and bending of bars; membrane theory of pressure vessels; combined loading conditions; transformation of stresses and principal stresses; elastic stability, elected topics. Typically offered Fall Spring Summer. Prerequisites: (Undergraduate level ME 27000 Minimum Grade of D- or Undergraduate level CE 29700 Minimum Grade of D- or Undergraduate level CE 27100 Minimum Grade of D- or Undergraduate level ME 27100 Minimum Grade of D-).

PHYS 17200 Modern Mechanics. Credit Hours: 4.00. Introductory calculus-based physics course using fundamental interactions between atoms to describe Newtonian mechanics, conservation laws, energy quantization, entropy, the kinetic theory of gases, and related topics in mechanics and thermodynamics. Emphasis is on using only a few fundamental principles to describe physical phenomena extending from nuclei to galaxies. 3-D graphical simulations and numerical problem solving by computer are employed by the student from the very beginning. Typically offered Summer Fall Spring. Prerequisites: (Undergraduate level MA 16100 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 16300 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 16700 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MATH 16300 Minimum Grade of D- [may be taken concurrently] or Undergraduate level MA 16500 Minimum Grade of D- [may be taken concurrently]) or (Undergraduate level MA 22100 Minimum Grade of D- [may be taken concurrently] and Undergraduate level MA 22200 Minimum Grade of D- [may be taken concurrently]) or (Undergraduate level MA 22300 Minimum Grade of D- [may be taken concurrently] and Undergraduate level MA 22400 Minimum Grade of D- [may be taken concurrently]) or Undergraduate level MATH 16500 Minimum Grade of D- [may be taken concurrently].

PHYS 24100 Electricity and Optics. Credit Hours: 3.00. Electrostatics, current electricity, electromagnetism, magnetic properties of matter. Electromagnetic waves, geometrical and physical optics. Typically offered Summer Fall Spring. Prerequisites: Undergraduate level PHYS 15200 Minimum Grade of D- or Undergraduate level PHYS 17200 Minimum Grade of D- or (Undergraduate level PHYS 16200 Minimum Grade of D- and Undergraduate level PHYS 16300 Minimum Grade of D-).

Agricultural Selectives – Machine Systems/ENRE

CREDIT	PREFIX	NUMBER
1 to 4	ABE	10000-59999
1 to 4	AGEC	10000-59999
1 to 4	AGR	10000-59999
1 to 4	AGRY	10000-59999
1 to 4	ANSC	10000-59999
1 to 4	ASM	10000-59999
1 to 4	BCHM	10000-59999
1 to 4	BTNY	10000-59999
1 to 4	ENTM	10000-59999
1 to 4	FNR	10000-59999
1 to 4	FS	10000-59999
1 to 4	HORT	10000-59999
1 to 4	LA	10000-59999
1 to 4	NRES	10000-59999
1 to 4	YDAE	10000-59999

Engineering Technical Selectives-Machine Systems

CREDIT	PREFIX	NUMBER	TITLE
3	ABE	35400	Transport Processes In Biological and Food Process Systems
3	ABE	46000	Sensors & Process Controls
1-3	ABE	49500	Select Topics in Agricultural and Biological Engineering
1-3	ABE	49800	Undergraduate Research in Agricultural and Biological Engineering
1-3	ABE	49900	Honors Thesis Research
3	ABE	50100	Welding Engineering
3	ABE	54500	Design of Off-Highway Vehicles
3	ABE	58000	Process Engineering of Renewable Resources
3	ABE	53100	Instrumentation and Data Acquisition
3	ECE	20700	Electronic Measurement Techniques
1-6	EPCS	101-406	Engineering Projects in Community Service
3	IE	34300	Engineering Economics
3	IE	37000	Manufacturing Processes I
3	IE	57700	Human Factors in Engineering
1-6	GEP		Global Engineering Projects
3	ME	26300	Introduction to Mechanical Engineering Design
3	ME	30000	Thermodynamics II
3	ME	31500	Heat and Mass Transfer
3	ME	36500	Systems and Measurements
3	ME	37500	System Modeling and Analysis
3	ME	41300	Noise Control
3	ME	41800	Engineering of Environmental Systems and Equipment
3	ME	43000	Power Engineering
3	ME	44000	Internal Combustion Engines
3	ME	47500	Automatic Control Systems
3	MSE	23000	Structure & Properties of Materials

Environmental and Natural Resources Engineering Technical Selectives

CREDIT	PREFIX	NUMBER	TITLE
3	ABE	46000	Sensors and Process Control
1-3	ABE	49500	Select Topics in Agricultural and Biological Engineering
1-3	ABE	49800	Undergraduate Research in Agricultural and Biological Engineering
1-6	ABE	49900	Honors Thesis Research
3	ABE	52200	Ecohydrology
3	ABE	52500	Irrigation Management and Design
3	ABE	52700	Computer models in Environmental and Natural Resources Engineering
3	ABE	52900	Nonpoint Source Pollution Engineering
3	ABE	53100	Instrumentation and Data Acquisition
1-6	ABE	59000	Special Problems
1-6	ABE	59100	Special Topics
1-6	ABE	59200	Special Topics II
3	CE	35500	Engineering Environmental Sustainability
3	CE	54200	Hydrology
3	AGRY	33700	Environmental Hydrology
1	AGRY	33800	Environmental Hydrology Laboratory
3	AGRY	54500	Remote Sensing of Land Resources
3	ASM	54000	GIS Applications
3	FNR	55800	Digital Remote Sensing and GIS

Engineering Technical Selectives – ENRE

CREDIT	PREFIX	NUMBER	TITLE
3	ABE	43500	Hydraulic Control Systems for Mobile Equipment
3	ABE	45400	Transport Processes in Biological and Food Process Systems
3	ABE	46000	Sensors and Process Control
1-3	ABE	49500	Select Topics in Agricultural and Biological Engineering
1-3	ABE	49800	Undergraduate Research in Agricultural and Biological Engineering
1-6	ABE	49900	Honors Thesis Research
3	ABE	52200	Ecohydrology
3	ABE	52500	Irrigation Management and Design
3	ABE	52700	Computer models in Environmental and Natural Resources Engineering
3	ABE	52900	Nonpoint Source Pollution Engineering
3	ABE	53100	Instrumentation and Data Acquisition
3	ABE	54500	Design of Off-Highway Vehicles
3	ABE	58000	Process Engineering of Renewable Resources
3	CE	35200	Biological Princ. Of Environmental Engineering
3	CE	35300	Physico--Chemical Princ. Of Environ. Engr.
3	CE	35500	Engineering Environmental Sustainability
3	CE	40800	Geographic Information Systems in Engineering
3	CE	44000	Urban Hydraulics
3	CE	44300	Introductory Environmental Fluid Mechanics
3	CE	45600	Water and Wastewater Treatment
3	CE	45700	Air Pollution Control And Design
3	CE	49700	Introduction to Architectural Engineering
3	CE	51100	GPS surveying
3	CE	54000	Open Channel Hydraulics
3	CE	54100	Design Of Hydraulic Structures
3	CE	54200	Hydrology
3	CE	54300	Coastal Engineering
3	CE	54400	Subsurface Hydrology
3	CE	54500	Sediment Transport Engineering
3	CE	54600	Computational River Hydraulics
3	CE	54900	Computational Watershed Hydrology
3	CE	55000	Physico--Chemical Processes In Environ. Engr.
3	CE	55400	Aquatic Chemistry in Environmental Engineering
3	CE	55500	Microbial Degradation of Pollutants
3	CE	55700	Air Quality Management
3	CE	55900	Water Quality Modeling
3	CE	59300	Environmental Geotechnology
3	EEE	43000	Industrial Ecology and LCA

1-2	EPCS	30100, 30200	Junior Participation in EPICS - Three credits of EPICS (typically taken over two semesters) on an environmental engineering related project team
1-2	EPCS	41100, 41200	Senior Design Participation in EPICS - Three credits of EPICS (typically taken over two semesters) on an environmental engineering related project team
1-6	GEP		Global Engineering Projects