PURDUE
UNIVERSITY

2008-2009

Agricultural and Biological Engineering Student Handbook

Agricultural Systems Management
Agricultural & Natural Resources Engineering
Biological and Food Process Engineering

(For students beginning college career Fall 2006 & after)

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Purdue University

Agricultural & Biological Engineering

ABE Building

Student Academic Center, Room 201

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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 conservation management of land and water resources. A student can select from these programs: Agricultural Systems Management (ASM), Agricultural and Natural Resources Engineering (ANRE) [specializing in either Machine Systems Engineering (MSE) or Environmental and Natural Resources Engineering (ENRE)], or Biological and Food Process Engineering (BFPE). Both the ANRE and BFPE programs lead to a BS in Agricultural and Biological Engineering, while the ASM program leads to a BS in Agriculture. The Biological and Food Process Engineering program offers dual degrees with either Pharmaceutical Sciences or Biochemistry. ABE also offers a BS/MS program. Courses in the ABE programs of study are very interesting and stimulating. These programs are each explained later in this handbook.

Employment opportunities for ABE students will undoubtedly continue to increase as the world populations demand more abundant supplies of nutritious, high quality food and biologically based products at affordable prices. Increased opportunities will also result from greater recognition of the needs for an abundant supply of clean water and preservation of natural resources. ABE students are uniquely qualified to cope with the various engineering and management aspects of production and processing of food and other biological materials within the constraints of environmental protection and natural resources conservation.

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 programs are to produce graduates who:

1. effectively practice agricultural and biological engineering in the areas of machine systems, and environmental and natural resources;
2. have demonstrated proficiency in fundamental engineering skills and technical knowledge as well as professional and personal skills appropriate for their profession;
3. are prepared for future challenges in agricultural and biological engineering through the application and discovery of knowledge; and
4. learn and grow as individuals, contribute to society, and attain maximum potential through life-long learning.

To achieve the program educational objectives the department will:

Provide students with effective educational opportunities to learn and grow as individuals, contribute to society, and attain maximum potential through life-long learning.

- Recruit quality students.
- Provide quality advising, mentoring, and placement.
- Provide students with technical and complementary knowledge and skills appropriate to their professions and life-long learning (see ASM, ANRE, and BFPE Program Outcomes).
- Provide professional enrichment opportunities.

Program Outcomes
Program outcomes are important capabilities and skills that students should possess as a graduate of one of the undergraduate programs in the department. Outcomes for various undergraduate programs, namely Agricultural Systems Management (ASM), Agricultural and Natural Resources Engineering (ANRE), and Biological and Food Process Engineering (BFPE) are listed below.

ASM Program Outcomes

ASM students will have the ability to:

1. understand and apply the basic principles of mathematics, science, technology, management, and economics to agricultural systems.
2. identify agricultural systems problems, locate relevant information, develop and analyze possible alternatives, and formulate and implement solutions.
3. effectively use economic principles, scientific technologies, techniques, and skills necessary to manage agricultural systems.

4. recognize and define agricultural systems problems and the impact of their proposed technological solutions in an international and societal context.
5. understand and participate in performance evaluations, collect, analyze and interpret the data, and communicate the results.
6. demonstrate appropriate listening, speaking, writing, presentation, and interpersonal skills needed to interact and communicate effectively.
7. function with, and contribute effectively to, multi-disciplinary teams.
8. understand professional and ethical responsibilities and put them into practice.

ANRE Program Outcomes

Graduates of the ANRE program will demonstrate:

I. Basic Engineering Skills

1. An understanding of the agricultural and biological engineering profession and practice;
2. The ability to understand and apply knowledge of mathematics, science, and engineering;
3. An understanding of, and the ability to identify, formulate, and model and solve problems for engineering systems;
4. The ability to design a system, component, or process to meet desired goal subject to constraints;
5. An ability to design and/or conduct experiments and analyze and interpret data;
6. Effective use of appropriate techniques, skills, and state-of-the-art engineering tools necessary for engineering practice.

II. Professional and Personal Skills

7. An understanding of the global and societal impact of engineering practice, research, and discovery;
8. A knowledge of contemporary issues;
9. Appropriate and effective writing, speaking, and listening skills;
10. The ability to function on, and contribute effectively to, a multi-disciplinary team;
11. The ability to understand and practice ethical responsibility in personal and professional life; and
12. An appreciation for the value of life-long learning to maintain “life-balance” and achieve maximum potential.

BFPE Program Educational Objectives and Outcomes

The educational objectives of the Biological and Food Process Engineering program are to produce graduates who:

1. effectively practice Biological and Food Process Engineering for the design and operation of systems for processing of biological materials to develop products for the food, pharmaceutical, and biochemical industries.
2. have demonstrated proficiency in fundamental engineering skills and technical knowledge as well as professional and personal skills appropriate for their profession.
3. are prepared for future challenges and opportunities in the areas of food, pharmaceutical and biochemical engineering through the discovery and application of knowledge.
4. learn and develop as individuals, contribute to the profession and society, and attain maximum potential through life-long 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 application of knowledge.

Graduates of the BFPE program will demonstrate:

I. Basic Engineering Skills

1. An understanding of the fundamental principles of mathematics and science;
2. An understanding of biological and food process engineering principles;
3. The ability to design and/or conduct experiments to analyze biological and food systems and processes;
4. An understanding of, and the ability to, identify, formulate, model, and solve problems for biological and food process engineering systems;
5. An ability to design a system or a process to meet desired needs in the area of biological and food process engineering;
6. Effective use of appropriate techniques, skills, and state-of-the-art engineering tools necessary for engineering practice.

II. Professional and Personal Skills

7. An understanding of the global and societal impact of engineering practice, research, discovery, entrepreneurship, and business;
8. A knowledge of contemporary issues;
9. Appropriate and effective writing, speaking, and listening skills;
10. The ability to function on, and contribute effectively to, a multi-disciplinary team;
11. The ability to understand and practice ethical responsibility in personal and professional life; and
12. An appreciation for the value of life-long learning to maintain “life-balance” and achieve maximum potential.

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. These notices include full- and part-time positions, summer and internship opportunities. Interview schedules are arranged by the Placement Coordinator. 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.

Student Clubs

Many ABE students belong to professionally related societies such as: American Society of Agricultural and Biological Engineers (ASABE); American Association of Pharmaceutical Scientists (AAPS); American Institute of Chemical Engineers (AIChE); Institute of Food Technologists (IFT); Purdue Society of Professional Engineers (PSEF); Society of Automotive Engineers (SAE); and Society of Women Engineers (SWE).

There are also college-wide opportunities such as Ag Council or Purdue Engineering Student Council. In addition, Purdue is host to many different student organizations - from Alpha Phi Omega (a service organization) to the Recreational Fishing Club - there is something for everyone!

The following Student Organizations are based in ABE. A faculty member assumes advisory responsibility for each club and ABE provides the student clubs with secretarial and administrative services that help encourage student participation.

American Society of Agricultural and Biological Engineers (ASABE) - The student branch promotes the interests of students in agricultural, biological and food process engineering, especially toward professional advancement through the parent society. Activities include picnics, guest speakers, lawn mower winterization, 1/4-scale Tractor Pull, and trips to ASABE annual international meetings. Club Advisors: Prof. R. Mohtar, ABE 321, 494-1791, mohtar@ecn.purdue.edu and Prof. J. Lumkes, ABE 314, 494-1173, lumkes@purdue.edu.

Agricultural Systems Management (ASM) - The Purdue University Agricultural Systems Management Club was established in 1968. The purpose of the club is to promote the Agricultural Systems Management program, its members, and to establish a social and personal atmosphere between students and faculty. Activities of the club include picnics, banquets, guest speakers, alumni relations, plant trips, service projects and various other activities. Club Advisors: Prof. D. Ess, ABE 311, 496-3977, ess@ecn.purdue.edu and Prof. D. Buckmaster, ABE 217, 496-9512, dbuckmas@purdue.edu.

Alpha Epsilon Honorary - Alpha Epsilon is a nationally affiliated honorary for students in agricultural and biological engineering. Club Advisors: TBA

Alpha Mu Honorary - Alpha Mu is the honor society for the Agricultural Systems Management program. Students are elected to membership based primarily on their academic standing. The club seeks to promote scholarship and excellence in all areas of Agricultural Systems Management.Club. Advisor: Prof. D. Jones, ABE 208B, 494-1178, jonesd@purdue.edu.

Biochemical and Food Process Engineering - The Biochemical and Food Process Engineeringclub is chartered to increase industry awareness of the biochemical and food process engineering degree. Club Advisor: Prof. Martin R. Okos, FS 1171, 494-1211, okos@ecn.purdue.edu

Biological Engineering in Genetics (BEG) - The Biological Engineering in Genetics club combines biological and engineering principles to design and build genetically engineered machines. The club travels to Boston to compete in an annual competition sponsored by MIT. Club Advisor: Prof. Jenna Rickus, BMED 2029, 494-1197, rickus@purdue.edu.

Professional Experience Programs

The Professional Experience Program includes internships (single periods of supervised work experience) and the Professional Practice program (a comprehensive program, formerly known as Co-Op) and combines education on campus with practical, career-oriented experience on the job.

Students must have completed the freshman year (30 semester credits) and be in good standing to be eligible (most employers expect at least a 3.0 GPA, however, some will accept a 2.8). Interested students are not guaranteed entry to the program since employers select students based upon normal interview procedures and approval of the position must be done by the departmental coordinator. A satisfactory summary report for each period of supervised work experience must be submitted by the student to the departmental coordinator.

Students who successfully complete an internship (minimum 10 weeks of supervised work experience) will be awarded an appropriate certificate by the School of Agriculture upon graduation.

ABE Professional Practice Education Program

Professional Practice Engineering Education at Purdue is a five-year professional development program designed to combine practical on-the-job experiences with the classroom training of a four-year college curriculum. The Professional Practice program allows students to see what engineering outside the classroom is all about - something no teacher, guidance counselor, or literature can really do. The objective of Purdue's Professional Practice program is to provide students with the best possible education by combining both academic and professional work experiences.

If you have finished your freshman year and have a 3.0 GPA or better, you should consider a Professional Practice position if you would like to: learn firsthand about potential careers by working directly with professionals in their field; and obtain a realistic view of the challenges, working conditions and rewards of being a member of the engineering profession.

Joining the Professional Practice program will add one year to a four year academic program. The Professional Practice schedule looks at the year as divided into 3 sessions, summer, fall, and spring, including vacations. A Professional Practice student will either be at work (registered in the Professional Practice Course) or on the West Lafayette campus (registered as a full time student). You should also be able to include a one or two week vacation. Engineering Professional Practice students participate in a total of five work sessions during their academic career. Neither you nor your employer are obligated to continue your working relationship after graduation, although, approximately half of Professional Practice students accept permanent employment with their Professional Practice employers upon graduation.

Not only will your Professional Practice experience enhance your resume, you will learn many of the diverse activities that engineers are involved with. You will acquire approximately 18 months of actual field experience and earn a good salary while completing your education. This combination of education and experience will make you a more marketable graduate, and you will be one rung up on the ladder of success.

The Agricultural & Biological Engineering Department has an active Professional Practice program with approximately 40 industrial companies and government agencies participating. Your faculty coordinator works closely with you throughout your entire Professional Practice experience to help you investigate potential employers offering work programs relevant to your chosen field of engineering, and assist you in selecting interviews, obtaining company information, writing resumes, and scheduling classes to meet the needs of a Professional Practice position.

For more information contact: Professor John Lumkes (Machine Systems Engineering) *OR* Dr. Martin Okos (Biological and Food Process Engineering). (See appendix for phone/email listings)

Honors Program

The College of Agriculture Honors Program can help you pursue an individually designed curriculum by working with a faculty mentor to do research or pursue other creative activities. In the Honors Program you'll find challenges and rewards.

Honors programs let you work with a faculty mentor to design your curriculum and set up additional research and learning activities.

Honors Program Operating Policies

- Students must have completed a minimum of 32 semester credits and have attained a minimum graduation index of 3.25 at the time of admission. Transfer students must complete a minimum of 16 credits at Purdue University before applying for admission. Individual departmental honors programs may establish higher criteria for admission.

- Students will apply for admission to the Honors Program through their departmental honors committee. Before applying for admission, the student is expected to identify an Honors Program adviser who has agreed to serve as a mentor and to determine a mutually acceptable honors project. Admission is contingent upon the approval of the departmental honors committee and the College of Agriculture Director of Academic Programs.

- Within the first semester after admission to the Honors Program, the student is expected to develop a plan of study in cooperation with his or her mentor. Plans of study are to be submitted to the departmental honors committee for approval. While in the Honors Program, students must achieve minimum 3.0 semester grade indexes. Participants who fail to meet the semester index requirement may continue in the Honors Program upon recommendation of the departmental honors committee and with the approval of the College of Agriculture Director of Academic Programs.

- Students in the Honors Program must complete a minimum of 30 credits in residence at the Purdue University West Lafayette Campus.

- Under the direction of his or her Honors Program mentor, the student must complete an honors project of scholarly activity associated with research, teaching, extension, or another area acceptable to the departmental honors committee. A written summary report of the honors project must be submitted to the departmental honors committee for approval. At the discretion of the departmental honors committee, the student may also be required to conduct a seminar regarding his or her honors project.

- To achieve certification as a College of Agriculture Honors Program graduate, the student must successfully complete the approved plan of study and submit a written honors project report which is approved by the departmental honors committee.

  Honors Program graduates will receive an appropriate certificate upon graduation, and the academic transcript will indicate successful completion of the Honors Program in the student's major program of study.

Special Projects Courses

Students may do a study or research project in an area not covered by their curriculum. The courses used for special projects are monitored by ABE faculty. They are: ABE 495 *Select Topics in Agricultural and Biological Engineering*, ABE 498 *Undergraduate Research in Agricultural and Biological Engineering*, and ABE 590 *Special Problems* for engineering credit; and ASM 490 or ASM 590 *Special Problems* for School of Agriculture credit. Assignment is by consent of the instructor in the field of selected study. Laboratory, field, and library studies and reports on special problems and research related to agricultural and biological engineering are required. Contract forms for ABE 495, 498, 590 and ASM 490 and 590 courses are available in the Student Academic Center. These forms must be completed and approval gained from the Academic Programs Committee *prior* to taking such a course in the ABE department. As an example, a sample form for ABE 590 is included in the Appendix.

Due to the extensive time required to plan and complete a special topics course, instructor selection and completion of the appropriate contract should take place in the semester *prior* to the one in which the course is to be completed. *Registration for a special topics course after two weeks into the semester will not be accepted.*

International Studies

Purdue University offers students within all fields of study the opportunity to participate in international study programs in more than 30 countries. There are approximately 20 programs in 13 countries which focus on various aspects of agriculture. Choices are as diverse as Russia, Honduras, Japan, and France. In most programs, students earn Purdue credit for courses completed. Although the academic experience is rigorous, programs allow extensive contact with the local culture.

Every effort is made to keep program costs as close as possible to the cost of study on the West Lafayette Campus. Students eligible for financial aid may use most forms of aid on approved programs. Students are responsible for their own airfare, board, room, books, and other personal expenses. There are a few selected programs where all expenses are paid. Certain College of Agriculture study abroad programs offer special scholarships to cover some costs.

Students may spend a year, a semester, or a summer abroad. Foreign language requirements vary from none to the advanced level. The language of instruction is English in more than 50 programs. Some programs are designed for students in specific areas of study; others are open to all Purdue students regardless of major.

For more information, contact: International Programs in Agriculture, Agricultural Administration Building, Room 26, (494-6876) *OR* Programs for Study Abroad, International Programs, Young Graduate House, Room 120 (494-2383).

International Studies Minor

The International Studies minor provides the opportunity for students to incorporate a special international component into their undergraduate program of study. Except for the overseas experiential component of the program, students usually are able to use the elective structure within their major program of study to earn the minor.

Students from any College of Agriculture major may earn the international studies minor. The Office of International Programs in Agriculture will provide special counsel to students regarding program operations including the identification and coordination or out-of-country experiences. To qualify for this minor, students normally will be expected to focus on a specific geographical region and complete the following requirements:

- Individuals must demonstrate proficiency in a second language
- Students must complete a minimum of 15 semester credits of courses with a principal international focus in the areas of culture, political science, history, or economics. A minimum of 6 credits of this coursework must be focused on the geographic region of choice.
- Individuals must participate in a cooperative work, internship, study abroad, or cultural exchange experience of eight weeks or more in the selected geographic region.
- Students must submit a summary paper and make an oral presentation.

See more information in the College of Agriculture catalog.

Scholarships

Agricultural and Biological Engineering students are eligible for scholarships awarded through both the College of Agriculture and College of Engineering. Available scholarships will be announced at various times during the academic year. Students should watch the bulletin boards and read their email for notices.

To apply for scholarships administered by ABE, a student must complete and submit a scholarship application form. Application forms are available on our website at https://engineering.purdue.edu/ABE From time to time scholarships will be made available from sources outside the department that will require a different application form. Those forms will also be made available in the Academic Center.

Scholarships administered by ABE have included, but are not limited to: Caterpillar, Deere, Fluid Power Educational Foundation, General Mills, John Greiner, Food Engineering Scholarship, G.W. Krutz, Nelson Irrigation, and Parker Hannifin.

Transfer Credit

Purdue University will accept transfer credit only for work done at those institutions fully approved by a regional accrediting association of secondary schools and colleges.

Students participating in college-credit courses taught concurrently for high school and college credit during the regular school day by local high school teachers must validate the credit through the subject department.

A CTR Form 5, Transfer Credit Evaluation Form, is to be used by Purdue degree seeking students who wish to take courses from another accredited college or university and have them approved for credit at Purdue prior to enrolling in the course(s). Students can do this in summer, while on Professional Practice, or intern jobs. CTR Forms are available from the Credit Evaluation Office in Schleman Hall.

Transfer Students -- New students transferring to Purdue from another school will have credits evaluated by the Credit Evaluation Office. Approved credits will be checked by the academic advisor to see if they meet graduation requirements in ABE.

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.

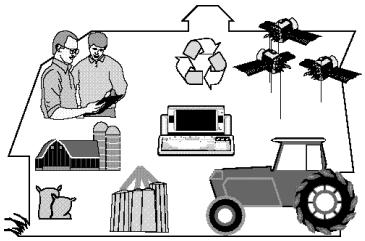
Agricultural and Natural Resources Engineering (ANRE)

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 ANRE 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 and Food Process Engineering (BFPE)

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 Systems Management



Agricultural Systems Management prepares individuals to organize and manage environmentally sound technology-based businesses. The emphasis is on planning and directing an industry or business project with responsibility for results. National and international job opportunities include:

- manufacturing and processing operations
- advice and trouble-shooting help on technical equipment (or projects)
- planning buildings and equipment to fit and work together, working with the handling and flow of materials such as grain, feeds, chemicals, vegetables, fruits, etc. and products made from them
  using technical training in selling or demonstrating products and equipment
- teaching people about product use and value
- manage and operate a farm or agri-business
- precision agriculture

Agricultural Systems Management is based on an understanding of how equipment and buildings are used with plants and animals and their products. These processes require an understanding of biological sciences to produce and maintain top product quality.

Computer skills are taught and used throughout the curriculum. Computers are used to collect and analyze data, and then using that information, to control machines and processes. Other uses involve planning layouts of equipment and buildings, creating graphics for reports, etc. While traditional computer programming is not taught, ASM students graduate with more computer application experience than any other students in the Agricultural complex.

Agricultural Systems Management students also take a series of courses in communications, business management and biological sciences, in addition to their specialty courses based in the Agricultural and Biological Engineering Department. The program provides an in-depth technical knowledge for selecting and applying advanced technologies in the food system. Graduates are prepared to solve a wide variety of business and technical problems in a job field that continues to grow.

CAREER OPPORTUNITIES

- Product Education - Use and Value
- Technical Assistance and Troubleshooting
- Technical Product Development, Testing, Application and Sales
- Farm & Agribusiness Management
- Coordinating, Directing and Supervising Manufacturing and Processing Operations
- Building and Equipment Layout, Use (Materials Handling, Flow, Processing)

Agricultural Systems Management Plan of Study

(Students entering Fall 2006 and after)

Credit Hours Required for Graduation: 131/132

Freshman Year

First Semester				Second Semester			
(1)	AGR	101	Introduction to the School of Agriculture and Purdue University	(3)	ASM	231	Computer Applications in Agriculture
(3)	ASM	104	Introduction to Agricultural Systems	(4)	EL – BIOL SCI		
(4)	EL – BIOL SCI			(3)	CHM	112	General Chemistry
(3)	CHM	111	General Chemistry	(3)	COM	114	Fundamentals of Speech Communication
(4)	ENGL	106	English Composition I	(3)	MA	220	Introduction to Calculus
(3)	EL - AG						
(18)				*(16)*			

Sophomore Year

Third Semester				Fourth Semester			
(3)	ASM	211	Technical Graphic Communications	(3)	ASM	245	Materials Handling & Processing
(1)	ASM	221	Career Opportunities Seminar	(1)	ASM	350	Safety in Agriculture
(3)	ASM	222	Crop Production Equipment	(3)	AGEC	220	Marketing Farm Products
(3)	AGEC	217	Economics	(3)	AGRY	255	Soil Science
(3)	EL - PHYS			(3)	EL – HUM/SS		
(3)	EL - HUM			(2)	EL – MATH/SCI		
(16)				*(15)*			

Junior Year

Fifth Semester				Sixth Semester			
(3)	ASM	336	Environmental Systems Mgmt	(3)	ASM	333	Facilities Planning & Mgmt
(3)	ASM	345	Power Units & Power Trains	(3)	AGEC	310	Farm Organization OR
(3)	EL - STATS					330	Mgmt Methods for Agricultural Business
(3)	EL - OLS			(3)	AGEC	331	Principles of Selling in Agric. Business
(3)	EL - ACCT			(2/3)	EL – AG		
(3)	EL – COM/ENGL			(3)	EL – INTL UN / INTL AG		
				(3)	EL - UNRES		
(18)				(17/18)			

Senior Year

Seventh Semester				Eighth Semester			
(3)	ASM	420	Electric Power and Controls	(3)	ASM	495	Agricultural Systems Mgmt
(1)	ASM	421	Senior Seminar	(3)	EL - AG		
(3)	EL - AG			(3)	EL – ASM/ABE 400+		
(3)	EL – MGMT 455/AGEC 455			(3)	EL – HUM/SS 300+		
(3)	EL – HUM/SS / INTL UN			(3)	EL – HUM/SS / INTL IN		
(3)	EL - UNRES						
(16)				*(15)*			

Agricultural Systems Management - Electives

Below is a list of typical electives for the ASM program

Agricultural (11/12 credits)

AGEC 411	Farm Management (4)
AGEC 420	Grain and Grain Products Marketing (1)
AGEC 424	Financial Management of Ag Business (4)
AGEC 426	Marketing Management of Agricultural Business (3)
AGRY 105	Crop Production (3)
AGRY 365	Soil Fertility (3)
AGRY 375	Crop Production Systems (3)
ANSC 102	Introduction to Animal Agriculture (3)
ANSC 221	Principles of Animal Nutrition (3)
ANSC 440-445	Horse/Beef/Sheep/Swine/Dairy/Poultry Mmgt (3)
ASM 201	Construction and Maintenance (3)
ASM 215	Surveying (3)
ASM 322	Technology for Precision Agriculture (3)
ASM 570	Agricultural Structures (3)
BTNY 304	Weed Science (3)
ENTM 105	Insects: Friend & Foe (3)
FNR 103	Introduction to Environmental Conservation (3)
FNR 240	Wildlife in America (3)
HORT 101	Fundamentals of Horticulture (3)

Agricultural – International Understanding (18 credits) (see complete listing of International Understanding courses on page 66)

AGEC 250	Economic Geography of World Food and Resources (3)
AGEC 340	Introduction to World Agricultural Development (3)
AGEC 450	International Agricultural Trade (3)
AGRY 285	World Crop Adaptation and Distribution (3)
AGRY 350	Global Awareness (1-3)
BTNY 201	Plants and Civilization (3)
FNR 230	The World's Forests and Society (3)
FNR 488	Global Environmental Issues (3)
HORT 306	History of Horticulture (3)
HORT 403	Tropical Horticulture (3)

Accounting

AGEC 311	Accounting for Farm Business Planning
MGMT 200	Introductory Accounting

Biological Science (8 credits)

BIOL 110	Fundamentals of Biology I (4)
BIOL 111	Fundamentals of Biology II (4)
BTNY 210	Introduction to Plant Science (4)
HORT 301	Plant Physiology (4)

Communications/English (3 credits)

ASL
COM 200+
ENGL 200+
YDAE 440+

Math/Science (2 credits)

AGEC 352	Quantitative Techniques for Firm Decision Making (3)
AGEC 451	Applied Econometrics (3)
AGRY 270	Forest Soils (3)
AGRY 320	Genetics (3)
AGRY 321	Genetics Laboratory (1)
ANSC 221	Principles of Animal Nutrition (3)
ANSC 230	Physiology of Domestic Animals (4)
BTNY 210	Introduction to Plant Science (4)
BTNY 301	Introduction to Plant Pathology (3)
BTNY 305	Fundamentals of Plant Classification (3)
BTNY 316	Plant Anatomy (4)
ENTM 206	General Entomology (2)
ENTM 207	General Entomology Laboratory (1)

OLS (3 credits)

OLS 252	Human Behavior in the Organization (3)
OLS 274	Applied Leadership (3)

Statistics (3 credits)

STAT 301	Elementary Statistics Methods (3)
STAT 501	Experimental Statistics I (3)
STAT 503	Statistic Methods for Biology (3)

Agricultural Systems Management
Associate Degree Plan of Study

Credit Hours Required for Graduation: 65

Freshman Year

First Semester

3	ASM	104	Introduction to Agricultural Systems
4	Biological Sciences Elective *		
3	CHM	111	General Chemistry
4	ENGL	106	English Composition I
3	Elective - Option		
17			

Second Semester

3	ASM	231	Computer Applications in Agriculture
3	CHM	112	General Chemistry
3	AGEC	217	Economics
3	HUM/SS Elective		
	MA 220 Introduction to Calculus OR		
	STAT 301 Elementary Statistical Methods		
15			

Sophomore Year

Third Semester

3	ASM	222	Crop Production Equipment
3	ASM	345	Power Units & Power Trains
3	AGEC	310	Farm Organization OR
		330	Mgmt Methods for Agricultural Business
3	COM	114	Fundamentals of Speech Communication
3	Elective - Option		
3	Elective - Option		
18			

Fourth Semester

3	ASM	245	Materials Handling & Processing
1	ASM	350	Safety in Agriculture
3	AGEC	220	Marketing Farm Products
3	Elective - Communication		
3	Elective - Option		
3	Elective - Unrestricted		
16			

***** Typical Biological Sciences Electives are BIOL 110, BIOL 111, or BTNY 210

ASM Program Electives

Program electives do not have to be taken in the ABE Department. Program electives may be from other departments depending on the plan of study developed between the student and their counselor.

ASM	201	Construction and Maintenance
ASM	211	Technical Graphics Communication
ASM	215	Surveying
ASM	322	Technology for Precision Agriculture
ASM	333	Facilities Planning and Management
ASM	336	Environmental System Management
ASM	420	Electric Power and Controls **
ASM	477	Rural Environmental Waste Management **

** Depends on what courses are selected as program electives as to whether the student has the background information to take this course.

Agricultural Systems Management Course Descriptions

<u>Required Courses</u> (Catalog Descriptions)

AGEC 217 Economics. Sem. 1 and 2. SS. Class 3, cr. 3. National economic problems such as unemployment, recessions, inflation, taxation, bank interest rates, the growth of government, monetary systems, and a rising national debt are discussed along with the principles, policies, and institutions for solving these macroeconomic problems.

AGEC 220 Marketing Farm Products. Sem. 1 and 2. Class 3, cr. 3. Types of markets; middlemen and their services; the relationship of production and consumption; price determining factors. Consideration given to major marketing issues, such as decentralization, integration, costs and margins, government regulations, marketing orders, promotion, grades and standards, and cooperatives.

AGEC 310 Farm Organization. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Economic factors controlling success in farming; types of farming; business records and analysis; adjustment in organization to meet changing economic conditions; organization and management of successful farms. ***OR AGEC 330***

AGEC 330 Management Methods for Agricultural Business. Sem. 1 and 2. Class 3, cr. 3. Management of nonfarm, agriculturally related businesses. Topics include tools for management decision making, legal forms of business organization, basics of accounting, and important financial management techniques. Case studies and computer simulation game. ***OR AGEC 310***

AGEC 331 Principles of Selling in Agricultural Business. Sem. 1 and 2. Class 2, cr. 3. The principles of salesmanship and their application to the agricultural business. Topics include attitudes and value systems, basic behavioral patterns, the purchase decision process, relationship of sales to marketing, selling strategies, preparing for sales calls, making sales presentations, handling objections, and closing sales. Emphasis is placed on application of principles to real-world situations and on building selling skills through class projects.

AGEC 455 Agricultural Law. Sem. 1, Class 3, cr. 3. Selected general legal topics (courts, contracts, torts, property and commercial law) with emphasis on farming problems (e.g., landowner-tenant, grain contracts, fences, and animal liability) and cases. ***OR MGMT 455***

AGR 101 Introduction to the College of Agriculture and Purdue University. Sem. 1. Class 2, cr. 1. Course meets during weeks 1-8. Students are introduced to the College of Agriculture and Purdue University. Specific areas discussed include the diversity of career opportunities within agriculture, the relationships between different areas of agriculture, ethics, the impact of undergraduate coursework, including the core curriculum, on scholarship and career preparation, and the challenges facing the food, agricultural, and natural resource system. The use of guest lectures provides a networking opportunity for students.

AGRY 255 Soil Science. Sem. 1 and 2. Class 1, rec. 1, lab. 1, cr. 3. Prerequisite: one year of college chemistry. 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.

ASM 104 Introduction to Agricultural Systems. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Basic principles of selection and operation of agricultural production equipment, including farm tractors and machines and crop-processing equipment. Planning considerations for crop storage and animal production systems and devices for water conservation and erosion control.

ASM 211 Technical Graphics Communications. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite: ASM 231. Introduction to graphic communication methods using traditional techniques and emphasizing modern computer based techniques. Topics covered include: free-hand sketching, lettering, and dimensioning; selection of data presentation methods; and plan interpretation and cost calculations. A majority of assignments will include use of commercially available computer-aided drawing packages.

ASM 221 Career Opportunities Seminar. Sem. 1, Class 1, cr. 1. An introductory course to acquaint students with career and employment opportunities in the field of agricultural systems management. Guest speakers are invited to share their experiences and philosophies with the students. Special emphasis is given to improving communications skills.

ASM 222 Crop Production Equipment. Sem. 1, Class 2, lab. 1, cr. 3. Prerequisite: ASM 231 or consent of instructor. Principles of machine performance, capacity, machinery components and operations. Study of tractors, trucks, utility vehicles and combines. Equipment topics include chemical application, tillage tools, planters and seeders, hay and forage harvesters, electronic monitors and controllers. Computer-based analysis of equipment sizing and systems selection.

ASM 231 Computer Applications in Agriculture. Sem. 2. Class 3, cr. 3. A study of the use of computers to solve problems on the farm and in agribusiness. Topics covered include hardware and software selection and evaluation, operating systems, word processing, electronic communications, spreadsheets, report preparation, and data base managers.

ASM 245 Materials Handling And Processing. Sem. 2. Class 2, lab. 2, cr. 3. Prerequisite: ASM 231 or equivalent. Principles of materials handling and processing. Physical properties and characteristics of food, fiber and feed materials as related to harvesting, handling, processing and storage. Processing of agricultural materials including drying, preservations, size reduction (e.g. grinding, crushing, shredding), mixing and blending, refrigeration, extrusion, and pelleting. Conveying and transport systems with consideration of their effects on damage and quality. The course elements are tied together by a treatment of scheduling and coordination of biologically based systems which involve production, handling, quality control and processing.

ASM 333 Facilities Planning And Management. Sem. 2, Class 2, lab. 1, cr. 3. Prerequisite: ASM 231 or equivalent. Principles of facility (system) planning and management involving buildings, equipment and materials handling and flow. Student teams select a case firm (problem) with instructor approval. Principles learned week by week are applied to the development of an overall plan for the complex, over the course of the semester. Case examples can include firms handling supplies, seeds, grains, feeds, chemicals, wastes and farm produce, as well as farming operations producing grain, forage and/or livestock products. Students will learn to use AutoCAD to develop drawings, without prior computer drafting experience.

ASM 336 Environmental Systems Management. Sem. 1. Class 3, cr. 3. Analysis of environmental systems with special emphasis on non-urban and agribusiness needs. Technological and sociological solutions to environmental problems. Computer-based tools are used to analyze global environmental issues, chemical use, waste disposal and management, water and air quality, soil and water conservation, sustainable agriculture, regulatory and policy issues.

ASM 345 Power Units And Power Trains. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: ASM 231 or equivalent. An introduction to power generation and transfer in mechanical and fluid power systems. Internal combustion engines, fuels, and cycles are introduced. Clutches, mechanical transmissions, automatic transmissions, hydrostatic transmissions, and final drives are discussed. Principles of hydraulics, fluids, cylinders, pumps, motors, valves, hoses, filters, reservoirs, and accumulators are studied.

ASM 350 Safety in Agriculture. Sem. 2. Class 1, lab. 1, cr. 1. Course meets during weeks 1-8. An overview of the agricultural safety movement in the United States with consideration given to the specific human environmental and technological factors influencing farm-related accidents. Special emphasis is given to reduction of unnecessary risks in agricultural production.

ASM 420 Electric Power & Controls. Sem. 1. Class 2, lab. 1, cr. 3. Fundamentals and application of electric power for agricultural facilities; safe wiring principles; operation and performance characteristics of electric motors; applications of control systems that include monitors, sensors, relays and programmable logic controllers.

ASM 421 Senior Seminar. Sem. 1. Class 2, cr. 1. For seniors in agricultural systems management program. Professional attitudes and ethics, technical report data presentation, interview procedures, resume preparation, and producer-consumer relationships.

ASM 495 Agricultural Systems Management. Sem. 2. Class 1, lab. 1, cr. 3. Planning, organization and analysis of individual or team projects related to contemporary issues in Agricultural Systems Management.

CHM 111 General Chemistry. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite: Two years of high school algebra or consent of instructor. Not available for credit toward graduation in the School of Science. Required of all freshmen in the College of Agriculture who are not in CHM 115 and required of students in the School of Consumer and Family Sciences in retailing, textile, RHIT, and dietetics options who are not in CHM 115. Required of students in physical therapy who are not in CHM 115. Not available for credit toward graduation in the School of Science. Metric and S.I. Units; dimensional analysis; density; the atomic concept; elements, compounds, and mixtures; the mole concept; equations and stoichiometry; atomic structure, spectra; the periodic table; chemical bonding, gases; descriptive chemistry of the common elements.

CHM 112 General Chemistry. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: CHM 111 or equivalent. Continuation of CHM 111. Liquids and solids; solutions; chemical kinetics; equilibrium; acids and bases; oxidation and reduction; electrochemistry; descriptive chemistry of the metals and nonmetals; introduction to organic chemistry; nuclear chemistry.

COM 114 Fundamentals of Speech Communication. Sem. 1, 2, and SS. Class 3, cr. 3. 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.

ENGL 106 First-Year Composition. Sem. 1, 2, and SS. Class 3, Rec. 1, cr. 4. Prerequisite: 6 credit hours at the lower division undergraduate level in Education, General or consent of instructor. Extensive practice in writing clear and effective prose. Instruction in organization, audience, style, and research-based writing.

MA 220 Introduction to Calculus. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: MA 153 or equivalent. A survey of differential and integral calculus. Applications to the agricultural, life, managerial, and social sciences.

MGMT 455 Legal Background For Business I. Sem. 1, 2, and SS. Class 2, cr. 3. The nature and place of law in our society, national and international, social and moral bases of law enactment, regulation of business, legal liability, and enforcement procedures. Special emphasis on torts, contracts, and agency. No credit to students in the School of Management. ***OR AGEC 455***

<u>Elective Courses</u> (Catalog Descriptions)

AGEC 250 Economic Geography of World Food and Resources. Sem. 1 and 2. Class 3, cr. 3. A study of the important issues and economic decisions about worldwide resource use for food and fiber production as influenced by geography, climate, history, social institutions, national self-interest, and the environment.

AGEC 311 Accounting for Farm Business Planning. Sem 1. Class 2, lab. 1, cr. 3. This course emphasizes the development of procedures for providing and using data in decision making. Methods will be addressed for finding and organizing both financial and physical data to provide the business information needed in planning and control. Topics discussed include budgeting, reporting unit costs of production, measuring profitability and wealth accumulation, estimating credit needs and income tax liability, and evaluating the strengths and weaknesses of the business as the basis for improving the business. A computerized commercial farm business accounting package will be thoroughly presented. ***OR MGMT 200***

AGEC 340 International Economic Development. Sem. 1. Class 3, cr. 3. Prerequisite: AGEC 217 or ECON 210 or 215 or 252. This course is designed to introduce students to issues and problems related to international economic development. Topics covered include a description of the current situation in developing countries and the history of growth and development. The course is grounded in the body of theory associated with economic development, but concentrates on the many practical problems such as poverty, population growth, urbanization, education and the environment. The three areas with the greatest attention are agricultural development, international trade, and policy analysis for developing countries.

AGEC 352 Quantitive Techniques For Firm Decision Making. Sem. 1, Class 2, rec. 1, cr. 3. Prerequisite: STAT 301. Introduction to mathematical programming and computing as an aid to agricultural decision making by firms, linear programming, game theory and strategy, simulation, the waiting-line problem, the equipment replacement decision, and multiproduct scheduling methods.

AGEC 411 Farm Management. Sem. 1. Class 2, lab. 1, cr. 4. Prerequisite: AGEC 310 and 311 or MGMT 200. Principles of farm organization and management, farmer interviews, and the application of computerized farm decision-making methods.

AGEC 420 Grain and Grain Products Marketing. Sem. 1. Class 2, cr. 1. Prerequisite: AGEC 220 and 321. Course meets during weeks 11-15. Fundamental and technical analysis of agricultural commodity prices. Role of supply and demand in determining market prices, futures markets in relation to cash markets, and analysis of alternative forward pricing methods. Interpretation of government crop and livestock reports, use and limitations of technical analysis in price forecasting. Requires class trips. Students will pay individual lodging or meal expenses when necessary.

AGEC 424 Financial Management of Agricultural Business. Sem. 1. Class 3, lab. 1, cr. 4. Prerequisite: MGMT 200 or consent of instructor. A study of the major types of financial decisions made by agriculturally related firms, including investment in inventory, receivables and cash, property, plant, and equipment; sources and types of short-term, intermediate, and long-term capital; legal patterns of the business organization, emphasis on implementation involving agribusiness case problems.

AGEC 426 Marketing Management of Agricultural Business. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: AGEC 311 or MGMT 200, AGEC 220 or 330, or senior status. A study of the major types of marketing strategy decisions that must be made by agribusiness firms, including target market selection; marketing research; sales forecasting; product policies; distribution channels; pricing, advertising, and personal selling; and marketing control.

AGEC 450 International Agricultural Trade. Sem. 1. Class 3, cr. 3. Prerequisite: AGEC 217 or equivalent, or consent of instructor. Study of U.S. agricultural trade with emphasis on international trade theory, exchange rates and their determination, relationships between domestic agricultural policies and trade policies, and analysis of institutional arrangements for world trade in agricultural products.

AGEC 451 Applied Econometrics. Sem. 2. Class 3, cr. 3. Prerequisite: STAT 305 or equivalent or consent of instructor. Application of strategies to economic problems. Simple and multiple regression, dummy variables, logit analysis, time series, and forecasting.

AGRY 105 Crop Production. Sem. 1 and 2. Class 2, lab. 2, cr. 3. Fundamental principles of crop production and distribution. Emphasis is places on applying technological advances in agronomy to active crop-production situations, including basic soils, agricultural meteorology, and crop physiology and breeding.

AGRY 270 Forest Soils. Sem. 2. Class 1, lab. 1, rec. 1, cr. 3. Prerequisite: one year of college chemistry or equivalent course or consent of instructor. Development, distribution, and classification of soil profile; soil characteristics related to forest practices; nature and cause of soil differences; fertility and plant nutrition. Not available to students who have taken AGRY 255/NRES 255.

AGRY 285 World Crop Adaptation and Distribution. Sem. 2. Class 3, cr. 3. Examination of how environmental factors, including climate and soils, impact the global distribution of major food crops. Identification of the types of naturally occurring plant communities and comparison of these communities with those of environmentally and economically sound field cropping systems. Exploration of how man's intervention has maintained or modified the productivity of food crops in agricultural communities and how his intervention has affected the environment.

AGRY 320 Genetics. Sem. 2. Class 3, cr. 3. Prerequisite: BIOL 110, 111 or equivalent course or consent of instructor. The transmission of heritable traits; probability; genotypic-environmental interactions; chromosomal aberrations; polyploidy; gene mutations; genes in populations; the structure and function of nucleic acids; biochemical genetics; molecular genetics; coding.

AGRY 321 Genetics Laboratory. Sem. 1 and 2. Lab. 1, cr. 1. Prerequisite: AGRY 320 or equivalent course or consent of instructor. Experiments with plants and microorganisms to elucidate the basic concepts of molecular and classical genetics as applied to genome analysis.

AGRY 350 Global Awareness. Sem. 2. Class 3, cr. 1-3. A seminar-type course about world geography, cultures, and agriculture. Speakers are selected from the many Purdue graduate students and visiting scholars from around the world. Extra credit may be earned through independent study of a global issue. Course may be repeated for up to a total of 4 credits.

AGRY 365 Soil Fertility. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: AGRY 255 or 270. Principles of soil chemistry and physics influencing plant nutrition; emphasis on diagnosis and solution of problems on soil reaction and nutrient status; fertilizer chemistry and use; reaction of pesticides and growth regulators with soils.

AGRY 375 Crop Production Systems. Sem. 1 and 2. Class 3, cr. 3. Factors affecting management decisions in crop production systems. Development of small grain and row cropping systems. Interaction of factors affecting efficient production systems, including seed selection, tillage, planting management, pest management, and harvesting and storage considerations.

ANSC 102 Introduction to Animal Agriculture. Sem. 1 and 2. Class 2, lab. 1, cr. 3. A study of animal agriculture emphasizing the efficient production of animal food products from poultry, dairy and meat animals. Credit cannot be obtained for both ANSC 101 and 102. Of ANSC 101, 102 and 106, only one course can be used as an ANSC elective.

ANSC 221 Principles of Animal Nutrition. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: CHM 112. Classification and function of nutrients, deficiency symptoms, digestive processes, characterization of feedstuffs, and formulation of diets for domestic animals.

ANSC 230 Physiology of Domestic Animals. Sem. 1 and 2. Class 4, cr. 4. Prerequisite: BIOL 110. A lecture course designed to present physiology of domestic farm animals. Function of tissues and organs, maintenance of internal steady-state conditions, and body responses to external environmental conditions will be presented. Physiological mechanisms involved in lactation, growth, and reproduction will be included.

ANSC 440 Horse Management. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: ANSC 221. Current breeding, feeding, housing, selection, disease control, and other management practices essential for sound economic planning of horse operations in today's horse industry. Laboratory farm visits provide students with real application examples and industry contacts.

ANSC 441 Beef Management. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: ANSC 221. Breeding, feeding, and management practices essential for economical beef production, including performance testing.

ANSC 442 Sheep Management. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: ANSC 221. Breeding, feeding, and management practices essential for economical sheep production and commercial lamb feeding, including performance testing.

ANSC 443 Swine Management. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: ANSC 221. Breeding, feeding, and management practices essential for commercial swine production, including performance testing.

ANSC 444 Dairy Management. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: ANSC 221. Current breeding, feeding, physiology, disease prevention, and management practices essential for economical milk production.

ANSC 445 Commercial Poultry Management. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: ANSC 221. Current developments and practices in the commercial production of eggs, broilers, and turkeys; principles of breeding, physiology, nutrition, management, and disease prevention.

ASM 201 Construction and Maintenance. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Fundamental principles in the selection and use of tools for the construction and maintenance of agricultural and related facilities, equipment, and machines. Areas covered include small engines, concrete and masonry, wood, plumbing, electricity, and metal.

ASM 215 Surveying. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Introduction to plane surveying. Instruction and practice in the use of surveying instruments for distance measurement, leveling, angle measurement, direction determination, traversing, and mapping. Office procedures for surveying data reduction. Practical problems and field exercises of the type encountered by the landscape architect and forester.

ASM 322 Technology for Precision Agriculture. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: ASM 231 or equivalent. Technology and applications of electronics for precision agriculture. Characteristics of personal computer hardware, electronic sensors, monitors, machine controllers, environmental monitors, and global positioning systems. Production management information systems; processing and marketing information systems; and yield mapping, geographic information system data handling, and software options.

ASM 570 Agricultural Structures. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: ASM 333 or consent of instructor. Structural, environmental, and functional problems of farm buildings; planning, estimating, and evaluating materials; costs, construction procedures, and practices.

BIOL 110 Fundamentals of Biology I. Sem. 1 and SS. Lec. 2, rec. 1, lab. 1, cr. 4. Principles of biology, focusing on diversity, ecology, evolution, and the development, structure, and function of organisms.

BIOL 111 Fundamentals of Biology II. Sem. 2. Lec. 2, rec. 1, lab. 1, cr. 4. Continuation of BIOL 110. Principles of biology, focusing on cell structure and function, molecular biology, and genetics.

BTNY 201 Plants and Civilization. Sem. 1. Class 3, cr. 3. This course, intended primarily for non-majors, covers the history of agriculture, with focus on the centers of origin of our major food, fiber, and medicinal plants, and their historical, cultural, and economic relevance. The course also surveys the biology of crop plants, with respect to taxonomy, anatomy, cell structure, physiology, development, and genetics. Discussion also center on the roles plant biotechnology may play in sustainable agriculture and in helping to alleviate problems caused by overpopulation and ecological stress.

BTNY 210 Introduction to Plant Science. Sem. 1 and 2. Class 3, lab. 1, cr. 4. An introduction to the major groups in the plant kingdom, their origin, classification, and economic importance. The areas of anatomy, morphology, cytology, physiology, biochemistry, molecular biology, genetics, and ecology will be explored as they relate to plant sciences and agriculture.

BNTY 301 Introduction Plant Pathology. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite: BTNY 210 or consent of instructor. Basic principles of plant pathology, including etiology, symptomatology, control, and epidemiology of representative diseases of plants.

BTNY 304 Introductory Weed Science. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: BTNY 210 or equivalent. A survey of the scientific principles underlying weed control practices; emphasis is on the ecology of weeds and control in crop associations. It is recommended that this course be followed by BTNY 504.

BTNY 305 Fundamentals of Plant Classification. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: BTNY 210 or consent of instructor. The principles of classification of seed plants, with emphasis on methods of identification in laboratory and field. Requires class trips. Students will pay individual lodging or meal expenses when necessary.

BTNY 316 Plant Anatomy. Sem. 2, Class 2, lab. 1, cr. 4. Prerequisite: BTNY 210 or consent of instructor. The internal structure of seed plants. Description and recognition of cell and tissue types, tissue systems, and their interrelations in vegetative and reproductive structures. Developmental changes of the plant body from embryo to mature plant and from meristems to mature tissues. Experimental approaches where relevant to structure-function relationships and to development will be introduced. Offered in odd-numbered years.

ENTM 105 Insects: Friend and Foe. Sem. 1 and 2. Class 3, cr. 3. A one-semester course for nonscience students who want to know more about insects - the most numerous organisms on earth. An introduction to insects and their relationship with humankind, including interesting aspects of insect biology; insects in music, decoration, history; use of insects in teaching at the elementary school level; their use in art, photography, and drawing; insects as human food.

FNR 103 Introduction to Environmental Conservation. Sem. 1 and 2. Class 3, cr. 3. Introduction to ecological principles, history of conservation, natural resource management, human impacts on the environment, and environmental ethics. For all students interested in an introductory natural resource or environmental science elective.

FNR 230 The World's Forests and Society. Sem. 1. Class 3, cr. 3. Examination of structure, function, and environmental and cultural significance of forest ecosystems throughout the world.

FNR 240 Wildlife in America. Sem. 1. Class 3, cr. 3. History of the occurrence, exploitation, and management of North America's wildlife resources. Life histories, habitat relationships, and human impacts on selected species. Current conservation practices and future prospects.

FNR 488 Global Environment Issues. Sem. 1. Class 3, cr. 3. Examination of the state of the world in terms of natural resource consumption, environmental quality, and global change. Techniques to analyze and evaluate information. Survey threats to soil productivity, the changing atmosphere, water quality and quantity, energy impacts, and biodiversity from an ecosystem perspective.

HORT 101 Fundamentals of Horticulture. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Biology and technology involved in the production, storage, processing, and marketing of horticultural plants and products. Laboratories include experiments demonstrating both the theoretical and practical aspects of horticultural plant growth and development. Requires class trips. Students will pay individual lodging or meal expenses when necessary.

HORT 301 Plant Physiology. Sem. 1. Calss 3, lab. 1, cr. 4. Prerequisite: BIOL 110 or 131, 132 or BTNY 210 or CHM 257 or consent of instructor. Basic physiological processes of higher plants, particularly as related to the influence of environmental factors on growth, metabolism, and reproduction. Laboratory experiments involve hands-on experience with numerous aspects of plant physiology, including water relations, photosynthesis, growth, dormancy, hormones, and flowering.

HORT 306Y History of Horticulture. Sem. 1, 2, and SS. Cr. 3. Distance learning that meets once per week. The origins and development of agriculture, with specific emphasis on horticulture from prehistory to the present in relation to civilization and modern culture.

HORT 403Y Tropical Horticulture. Sem. 1. Cr. 3. Distance learning that meets once per week. Offered in even-numbered years. An introduction to the agriculture of the tropics and subtropics, emphasizing horticultural crops.

MGMT 200 Introductory Accounting. Sem. 1 and 2. SS. Class 3, cr. 3. The objectives of the course are to help students: (1) understand what is in financial statements and what the statements say about a business, (2) identify the business activities that caused the amounts that appear in the statements, and (3) understand how, when, and at what amount the effects of manager and employee actions will appear in the statements. ***OR AGEC 311***

OLS 252 Human Behavior in Organizations. Sem. 1, 2, and SS. Class 3 or class 2, rec. 1, cr. 3. A survey of the concepts that provide a foundation for the understanding of individual and group behavior in organizations of work, with special emphasis on typical interpersonal and leadership relationships.

OLS 274 Applied Leadership. Sem. 1, 2, and SS. Class 3 or class 2, rec. 1, cr. 3. Introduction to, and overview of, the fundamental concepts of leadership and supervision.

STAT 301 Elementary Statistical Methods. Sem. 1, 2, and SS. Class 3, cr. 3. Prerequisite: MA 152. Introduction to statistical methods with applications to diverse fields. Emphasis on understanding and interpreting standard techniques. Data analysis for one and several variables, design of samples and experiments, basic probability, sampling distributions, confidence intervals and significance tests for means and proportions, correlation and regression. Software is used throughout. Not open to students in the Department of Mathematics and Schools of Engineering. Credit cannot be given for more than one of STAT 301, 305, 350, 433, 501, 503, and 511.

STAT 501 Experimental Statistics I. Sem. 1 and SS. Class 1, cr. 3. Prerequisite: Course work in algebra and number theory or consent of instructor. Concepts and methods of applied statistics. Exploratory analysis of data. Sample design and experimental design. Normal distributions. Sampling distributions. Confidence intervals and tests of hypotheses for one and two samples. Inference for contingency tables, regression and correlation, and one-way analysis of variance. Use of the SAS statistical software. Intended primarily for students who have not had calculus. Not open to students in mathematical sciences or engineering. Credit cannot be given for more than one of STAT 301, 305, 350, 433, 501, 503, or 511.

STAT 503 Statistical Methods for Biology. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: Course work in calculus or consent of instructor. Introductory statistical methods, with emphasis on applications in biology. Topics include descriptive statistics, binomial and normal distributions, confidence interval estimation, hypothesis testing, analysis of variance, introduction to nonparametric testing, linear regression and correlation, goodness-of-fit tests, and contingency tables. Open only to majors related to the life sciences. Credit cannot be given for more than one of STAT 301, 305, 350, 433, 501, 503, or 511.

AGRICULTURAL SYSTEMS MANAGEMENT STUDENT RECORD (STUDENTS ENTERING FALL 2006 -)

Name _____ Student ID No. ___ ___ ___ ___ ___ - ___ ___ ___ ___ ___

Freshman - 1				Sophomore - 3				Junior - 5				Senior - 7			
Sem	Subject & Number	Credit	Grade	Sem	Subject & Number	Credit	Grade	Sem	Subject & Number	Credit	Grade	Sem	Subject & Number	Credit	Grade
	ASM 104	3			ASM 211	3			ASM 336	3			ASM 420	3	
	AGR 101	1			ASM 221	1			ASM 345	3			ASM 421	1	
	EL – BIOL SCI	4			ASM 222	3			EL – STAT	3			EL – AG	3	
	CHM 111	3			AGEC 217	3			EL – OLS	3			EL – MGMT 455 / AGEC 455	3	
	ENGL 106	4			EL – PHYS	3			EL – ACCT	3			EL – HUM/SS / INTL UN	3	
	EL – AG	3			EL – HUM	3			EL – COM/ENGL	3			EL – UNRES	3	
Advisor sign./date		18		Advisor sign./date		16		Advisor sign./date		18		Advisor sign./date		16	

Freshman - 2				Sophomore - 4				Junior - 6				Senior - 8			
Sem	Subject & Number	Credit	Grade	Sem	Subject & Number	Credit	Grade	Sem	Subject & Number	Credit	Grade	Sem	Subject & Number	Credit	Grade
	ASM 231	3			ASM 245	3			ASM 333	3			ASM 495	3	
	EL – BIOL SCI	4			ASM 350	1			AGEC 310/330	3			EL – AG	3	
	CHM 112	3			AGEC 220	3			AGEC 331	3			EL – ASM / ABE 400+	3	
	COM 114	3			AGRY 255	3			EL – AG	2/3			EL – HUM/SS 300+	3	
	MA 220	3			EL – HUM/SS	3			EL – INTL UN / INTL AG	3			EL – HUM/SS / INTL UN	3	
					EL – MATH/SCI	2			EL – UNRES	3					
Advisor sign./date		16		Advisor sign./date		15		Advisor sign./date		17/18		Advisor sign./date		15	

International Understanding (9 credits) _____ _____ _____

Multicultural Awareness (3 credits) _____

AGRICULTURAL SYTEMS MANAGEMENT STUDENT RECORD (STUDENTS ENTERING FALL 2006 -)

Name _____ **Student ID #** ___ ___ ___ ___ ___ - ___ ___ ___ ___ ___

Home Address _____ **Date** _____
(record start date)

Entered Purdue
❑Fall ❑Spring ❑Summer 20___

Entered ASM Program
❑Fall ❑Spring ❑Summer 20___

Classification: (Fr2, So3, etc) Fr. ___ **So.** ___ **Jr.** ___ **Sr.** ___
Via: _____

GRADE INDICES

EP	Semester & Year	Graduation			Semester			School
		Index	Hours	Points	Index	Hours	Points	Status
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

Date	Advisor Comments

EP = enrollment period 1, 2, 3, etc.
Semester & Year = F07, S07, SS07, etc.
Sum of "Semester Hours" not necessarily the same as "Graduation Hours", depending on courses taken-over (if any).

Actual Date of Graduation _____(to be final entry on this record)

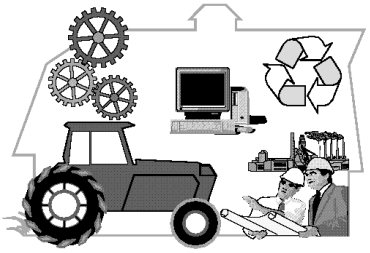
5/07

Agricultural Systems Management Associate Degree Student Record

First Semester				*Second Semester*			
sem	subject & number	credit	grade	sem	subject & number	credit	grade
	ASM 104	3			ASM 231	3	
	EL - Biol Sci	4			CHM 112	3	
	CHM 111	3			AGEC 217	3	
	ENGL 106	4			EL - HUM/SS	3	
	EL - Option	3			MA 220 / STAT 301	3	
advisor sig / date		17		advisor sig / date		15	

Third Semester				*Fourth Semester*			
sem	subject & number	credit	grade	sem	subject & number	credit	grade
	ASM 222	3			ASM 245	3	
	ASM 345	3			ASM 350	1	
	AGEC 310 / 330	3			AGEC 220	3	
	COM 114	3			EL - Com	3	
	EL - Option	3			EL - Option	3	
	EL - Option	3			EL - Unres	3	
advisor sig / date		18		advisor sig / date		16	

Agricultural and Natural Resources Engineering



Agricultural and Natural Resources Engineering (ANRE) prepares engineers for careers in industries whose products are based upon biological materials or on applications for production agriculture. Agricultural and natural resource engineers apply their knowledge of natural resource systems and engineering to equipment design and assure environmental compatibility of practices used by production agriculture. The ANRE 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 when the product or process involves 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 ANRE 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 and Natural Resource 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.

Areas of emphasis/specialization:

Machine Systems Engineering (MSE)

Environmental and Natural Resources Engineering (ENRE)

Agricultural and Natural Resources Engineering
Plan of Study
(Students entering Fall 2006 and after)

(Credit Hours Required for Graduation: 131

Freshman Year (ABE 120, Introduction to Ag & Biological Engineering, is recommended for the Freshman year)

First Semester				Second Semester			
1	AGR 101 Introduction to the School of Agriculture and Purdue University			4	Science Selective (CHM 116 for ENRE option; CHM 116 or CS 159 for MSE		
	OR ENGR 100 Freshman Engineering Lectures			(3)	option		
4	CHM	115	General Chemistry				
4	ENGL	106	English Composition I	3	COM	114	Fundamentals of Speech Communications
3	**ENGR**	**126**	**Engineering Problem Solving and Computer Tools**	4	MA	166	Plane Analytic Geometry and Calculus II
4	MA	165	Plane Analytic Geometry and Calculus I	4	**PHYS**	**172**	**Modern Mechanics**
				3			Humanities Elective
16				18 (17)			

Sophomore Year

Third Semester				**Fourth Semester**			
3	ABE	205	Engineering Computations for Biological Systems	3	ABE	210	Biological Applications of Material and Energy Balances
1	**ABE**	**290**	**Sophomore Seminar**	3	NUCL	273	Mechanics of Materials
4	MA	261	Multivariate Calculus	4	MA	262	Linear Algebra and Differential Equations
4	Biological Sciences Elective			3	ME	274	Basic Mechanics II
3	ME	270	Basic Mechanics I	3	Social Sciences Elective**		
3	PHYS	241	Electricity and Optics				
18				16			

Junior Year

Fifth Semester				Sixth Semester			
3	ABE	305	Physical Properties of Biological Materials	3	ABE	330	Design of Machine Components
4	ABE	325	Soil and Water Resource Engineering	4	Biological Sciences Elective		
3	AGRY	255	Soil Science	3	ECE	201	Linear Circuit Analysis I
4	CE 340 Hydraulics (3cr) AND CE 343 Elementary Hydraulics Lab (1cr)			3	Economics Elective**		
	OR ME 309 Fluid Mechanics (4 cr)			3	Free Elective		
3	Free Elective						
17				16			

Senior Year

Seventh Semester				Eighth Semester			
3	ABE	435	Hydraulic Control Systems for Mobile Equipment	4	ABE	485	Agricultural Engineering Design
3	ABE	450	Finite Element Method in Design and Optimization	3	Engineering Technical Elective		
1	ABE	490	Professional Practice in Agricultural & Biological Engineering	3	Social Sciences Elective**		
3	Engineering Technical Elective			3	Humanities Elective**		
3	Agricultural Elective			1	Free Elective (2 hours for those taking CS 159)		
3	Written and Oral Communication Elective**						
16				14 (15)			

** A total of eighteen credit hours of general education electives must be taken in accordance with the requirements of the College of Agriculture and Engineering.

Six credits within the plan of study must meet College of Agriculture International Understanding requirements.

Agricultural and Natural Resources Engineering
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 forest machinery and soil sensors, to developing prescription 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 just for fun. The basis of this ANRE area of study provides machine systems engineers an education to enjoy their careers solving problems.

Design courses build individual confidence and are one-on-one with engineers who submit actual problems. 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.

Machine Systems Engineering - Electives

The Agricultural and Natural Resources Engineering curriculum contains 6 credits of courses labeled ENGINEERING TECHNICAL ELECTIVE.

Below is a list of recommended and approved engineering courses which can be used to satisfy the footnote associated with those ELECTIVES for specialization in machine systems engineering (MSE). Other engineering courses can be selected but must be reviewed for acceptance on an individual basis. *See your academic advisor for additional assistance.*

Course	Title
ABE 320	Solid Modeling, Simulation and Analysis
ABE 454	Transport Processes In Biological and Food Process Systems
ABE 460	Sensors & Process Controls
ABE 495	Select Topics in Agricultural and Biological Engineering
ABE 498	Undergraduate Research in Agricultural and Biological Engineering
ABE 499H	Honors Thesis Research
ABE 580	Process Engineering of Renewable Resources
ABE 591Y	Instrumentation and Data Acquisition
ECE 207	Electronic Measurement Techniques
IE 343	Engineering Economics
IE 370	Manufacturing Processes I
IE 577	Human Factors in Engineering
ME 263	Introduction to Mechanical Engineering Design
ME 300	Thermodynamics II
ME 315	Heat and Mass Transfer
ME 365	Systems and Measurements
ME 375	System Modeling and Analysis
ME 413	Noise Control
ME 418	Engineering of Environmental Systems and Equipment
ME 430	Power Engineering
ME 440	Internal Combustion Engines
ME 475	Automatic Control Systems
MSE 230	Structure & Properties of Materials

Agricultural and Natural Resources Engineering
Emphasis Area: Environmental and Natural Resources Engineering

Agricultural and Natural Resources Engineering offers a unique perspective on environmental management that cannot be gained through other engineering or agricultural programs. Our agricultural 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 and enter the environment over a considerably wider area. Many of the environmental impacts of agriculture are due to nonpoint sources. 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 stable waterways for drainage/irrigation water; design equipment for manure land application that produces less odors which 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.

Environmental and Natural Resources Engineering - Electives

The Agricultural and Natural Resources Engineering curriculum contains 6 credits of courses labeled Engineering Technical Elective and 6 credits of Free Electives. Below is a list of recommended and approved engineering courses which can be used to satisfy the footnote associated with those electives for specialization in environmental and natural resources engineering (ENRE). Other engineering courses can be selected but must be reviewed for acceptance on an individual basis. *See your academic advisor for additional assistance.*

Engineering Electives

ABE 495	Select Topics in Ag. & Biol Engr
ABE 498	Undergrad Research in ABE
ABE 499H	Honors Thesis Research
ABE 580	Process Engr of Renewable Resources
ABE 590	Special Problems*
CE 350	Environmental Engineering
CE 352	Bio. Principles of Environmental Engr
CE 353	Physico-chemical Princ. of Envir. Engr
CE 440	Urban Hydraulics
CE 457	Air Pollution Control & Design
CE 540	Open Channel Hydraulics
CE 542	Hydrology
CE 544	Subsurface Hydrology
CE 545	Sediment Transport Engineering
CE 554	Aquatic Chem. in Environmental Engr.
CE 559	Water Quality Modeling
CE 593	Environmental Geotechnology
CHE 540	Transport Phenomena

*Such as: GIS, hydrologic/water quality modeling, advance soil & water conservation

Non-Engineering Electives ("Free Electives")

AGRY 540	Soil Chemistry
AGRY 544	Environmental Organic Chemistry
AGRY 545	Remote Sensing of Land Resources
AGRY 555	Soil & Plant Analysis
AGRY 560	Soil Physics
AGRY 582	Environmental Fate of Pesticides
AGRY 585	Soils & Land Use
ASM 211	Technical Graphics Communications
ASM 336	Environmental Systems Management
FNR 103	Intro to Environmental Conservation
FNR 353	Nat Resources Measurement
FNR/AGEC 406	Natural Resource & Environ Economics
FNR 488	Global Environmental Issues
FNR 558	Digital Remote Sensing & GIS
NRES/AGRY 450	Soil Conservation & Water Mgmt.
STAT 511	Statistical Methods
STAT 512	Applied Regression Analysis

Agricultural and Natural Resources Engineering Course Descriptions
Machine Systems / Environmental & Natural Resources

Required Courses (Catalog Descriptions)

ABE 205 Engineering Computations for Engineering Systems. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: ENGR 126. Corequisite: PHYS 172. 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.

ABE 210 Biological Applications of Material and Energy Balances. Sem. 2. Class 3, cr. 3. Prerequisite: CHM 116, CS 152 or 156, PHYS 152, or equivalent. 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.

ABE 290 Sophomore Seminar. Sem. 1. Class 1, cr. 1. 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.

ABE 305 Physical Properties of Biological Materials. Sem. 1. Class 2, lab. 1, cr. 3. Corequisite: ABE 205 and 210 or consent of instructor. Physical properties of agricultural crops and food products an their relationship to harvesting, storage, and processing. Physical properties covered include: density, shape, moisture content, water potential, water activity, friction and flow of particulate solids, terminal velocity, thermal properties, interaction with electromagnetic radiation, and viscoelastic behavior of solids.

ABE 325 Soil and Water Resource Engineering. Sem. 1. Class 3, lab. 1, cr. 4. Co-requisites: AGRY 255, and either ME 309 or CE 340 and CE 343. Interrelationships of the plant-water-air-soil system; hydrologic processes; protection of surface and ground water quality; GIS targeting of soil and water protections measures; and design of subsurface and overland drainage systems, irrigation systems, and soil erosion control practices.

ABE 330 Design of Machine Components. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: CE 273. 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.

ABE 435 Hydraulic Control Systems for Mobile Equipment. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: CE 340 or ME 309. Design of basic fluid power components and systems. Includes power steering, hydrostatic and hydro mechanical transmission, electro hydraulic servo valves, servomechanism, and manually controlled systems.

ABE 450 Finite Element Method in Design and Optimization. Sem. 1. Class 3, cr. 3. Prerequisite: ABE 330. Fundamentals of the finite element method as it is used in modeling, analysis, and design of thermal/fluid and mechanical system; one- and two- dimensional elements; boundary value problems; heat transfer and fluid flow problems; structural and solid mechanics problems involving beam, truss, frame, plate, and shell elements; computer-aided design and optimization of machine components, structural elements, and thermal/fluid system.

ABE 485 Agricultural and Biological Engineering Design. Sem. 2. Class 1, lab. 2, cr. 4. Prerequisite: ABE 325 and 330. Machine or environmental system design projects, team or individual, related to contemporary or potential problems in agricultural and biological engineering.

ABE 490 Professional Practice in Agricultural and Biological Engineering. Sem. 1. Lab. 2, cr. 1. Career areas in agricultural engineering; job opportunities and graduate study; professional attitudes and ethics; contracts and specifications; patents.

AGR 101 Introduction to the College of Agriculture and Purdue University. Sem. 1. Class 1, cr. 1. Course meets during weeks 1-8. Students are introduced to the College of Agriculture and Purdue University. Specific areas discussed include the diversity of career opportunities within agriculture, the relationships between different areas of agriculture, ethics, the impact of undergraduate coursework, including the core curriculum, on scholarship and career preparation, and the challenges facing the food, agriculture, and natural resource system. The use of guest lectures provides a networking opportunity for students. ***OR ENGR 100***

AGRY 255 Soil Science. Sem. 1 and 2. Class 1, rec. 1, lab. 1, cr. 3. Prerequisite: one year of college chemistry. 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.

CE 340 Hydraulics. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: CE 298 or consent of instructor. Fluid properties; hydrostatics; kinematics and dynamics of fluid flows; conservation of mass, energy, and momentum; flows in pipes and open channels. Formal laboratory experiments. ***AND*** **CE 343 Elementary Hydraulics Laboratory.** Sem. 1 and 2. SS. Lab 1, cr. 1. Corequisite: CE 340. 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. ***OR ME 309***

CHM 115 General Chemistry. Sem. 1 and 2. SS. Class 2, lab. 1, cr. 4. Prerequisite: MA 159. Corequisite: MA 161 or 223. One year of high school chemistry or one semester of college chemistry required. Stiochiometry; 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 CHM123.

CHM 116 General Chemistry. Sem. 1 and 2. SS. Class 2, lab. 1, cr. 4. Prerequisite: CHM 115 or equivalent. A continuation of CHM 115. Solutions; quantitative equilibria in aqueous solution; introductory thermodynamics; oxidation-reduction and electro-chemistry; chemical kinetics; qualitative analysis; further descriptive chemistry of metals and nonmetals.

COM 114 Fundamentals of Speech Communication. Sem. 1 and 2. SS. Class 3, cr. 3. 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

CS 159 Programming Applications for Engineers. Sem. 1 and 2. SS. Class 2, lab. 1, cr. 3. Corequisite: ENGR 116 or 126. 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.

ECE 201 Linear Circuit Analysis I. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: ENGR 126 Corequisite: MA 261. Volt-ampere characteristics for circuit elements; independent and dependent sources; Kirchhoff's laws and circuit equations. Source transformations. Thevenin's and Norton's theorems; superposition. Thansient response of RC, RL, and RLC circuits. Sinusoidal steady-state and impedance. Instantaneous and average power.

ECON 251 Microeconomics. Sem. 1 and 2. SS. Class 3, cr. 3. Price theory and resource allocation. Emphasis is on developing a detailed understanding of the principles of microeconomic analysis and their application to market behavior and public policy issues. ***OR ECON 252***

ECON 252 Macroeconomics. Sem. 1 and 2. SS. Class 3, cr. 3. Introduction to macroeconomic theory. The course develops a theoretical framework permitting an analysis of the forces affecting national income, employment, interest rates, and the rate of inflation. Emphasis is placed upon the role of government fiscal and monetary policy in promoting economic growth and stable prices. ***OR ECON 251***

ENGL 106 First-Year Composition. Sem. 1 and 2. SS. Class 3, rec. 1, cr. 4. Prerequisite: 6 credit hours at the lower division undergraduate level in Education, General. Extensive practice in writing clear and effective prose. Instruction in organization, audience, style, and research-based writing.

ENGR 100 Freshman Engineering Lectures. Sem. 1 and 2. Class 1, cr. 1 (Available pass/not-pass only.) An introduction to the engineering profession. ***OR AGR 101***

ENGR 126 Engineering Problem Solving and Computer Tools. Sem. 1 and 2. SS. Class 2, lab. 1, cr. 3. Corequisite: MA 165. Introduction to the solving of open-ended engineering problems and the use and of computer software, including UNIXTM, computer communications, spreadsheets, and MATLAB. Explicit model-development activities are utilized, and students are expected to develop skill at working in teams. This is emphasized both in laboratories and on projects.

MA 165 Analytic Geometry and Calculus I. Sem. 1 and 2. Class 3, cr. 4. Prerequisite: Demonstrated competency in college algebra and trigonometry at the level of MA 151. 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 162 or 166. Introduction to differential and integral calculus of one variable, with applications. Conic sections.

MA 166 Analytic Geometry and Calculus II. Sem. 1 and 2. Class 3, cr. 4. Prerequisite: MA 165. Continuation of MA 165. 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 162.

MA 261 Multivariate Calculus. Sem. 1 and 2. SS. Class 3, rec. 1, or Class 4, cr. 4. Prerequisite: MA 162 or 166. Not open to students with credit in MA 174 or 271. Planes, lines, and curves in three dimensions. Differential calculus of several variables; multiple integrals. Introduction to vector calculus.

MA 266 Ordinary Differential Equations. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: MA 261. First order equations, second and n'th order linear equations, series solutions, solution by Laplace transform, systems of linear equations. It is preferable but not required to take MA 265 either first or concurrently. Not open to students with credit in MA 262, 272, 360, 361, or 366.

ME 270 Basic Mechanics I. Sem. 1 and 2. SS. Class 3. cr. 3. Prerequisite: PHYS 152; corequisite: MA 261. 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.

ME 274 Basic Mechanics II. Sem. 1 and 2. SS. Class 3. cr. 3. Prerequisite: ME 270 or equivalent; corequisite: MA 262. 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.

ME 309 Fluid Mechanics. Sem. 1 and 2. Class 3., lab. 1, cr. 4. Prerequisite: ME 263, differential equations, dynamics, and a first course in thermodynamics. Continuum, velocity field, fluid statics, 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, turbo machinery. ***OR CE 340 and CE 343***

NUCL 273 Mechanics of Materials. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: ME 270.Analysis of stress and strain; equations of equilibrium and compatibility; stress-strain laws; extension, torsion, and bending of bars; membrane theory of pressure vessels; elastic stability, elected topics.

PHYS 172 Modern Mechanics. Sem. 1 and 2. SS. Class 2, rec. 1, lab. 1, cr. 4. Corequisite: MA 161. 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.

PHYS 241 Electricity and Optics. Sem. 1 and 2. SS Class 2, rec.2, cr. 3. Prerequisite: PHYS 152. Electrostatics, current electricity, electromagnetism, magnetic properties of matter. Electromagnetic waves, geometrical and physical optics.

Elective Courses (Catalog Descriptions)

ABE 281 Professional Internship. Sem. 1 and 2. SS. Cr. 0. Supervised professional experience in Agricultural and Biological Engineering. Program conducted under the direction of an engineering faculty member and cooperation of an employer. Students submit a summary report.

ABE 320 Solid Modeling, Simulation, and Analysis. Sem. 1. Class 1, lab. 2, cr. 3. Prerequisite: MA 262, NUCL 273. Corequisite: ME 274. 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.

ABE 454 Transport Processes in Biological and Food Process Systems. Sem. 2. Class 3, lab. 1, cr. 4. Prerequisite: CHE 377 or equivalent. Corequisite: CHE 378 or equivalent, or consent of instructor. Application of momentum and heat transfer to biological and food process engineering. Viscosity, Non-Newtonian fluids, experimental methods of rheological characterization of food and biological systems; viscoelasticity; design equations for pipeflow, pumps, mixing, emulsification, extrusion, sheeting, heat exchangers, aseptic processing, unsteady state heat transfer, sterilization, freezing, evaporation.

ABE 460 Sensors and Process Control. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: differential equations and a course in either heat transfer or fluid mechanics. Fundamental aspects of transducers, biosensors, instrumentation and computer control are presented with particular emphasis on sensors and controls used in agricultural, biological and food applications. Laboratory and pilot plant scale computer controlled equipment is used to examine response of process variables, sensor calibration, control system modeling and controller selection and tuning.

ABE 495 Select Topics in Agricultural and Biological Engineering. Sem. 1 and 2. SS. Cr. 1-3. Credit and hours to be arranged. Special topics and projects of contemporary importance or of special interest that are outside the scope of the standard agricultural and biological engineering curriculum. The specific topic that is offered will be indicated on the student's record. A written report and oral presentation of final results are required.

ABE 498 Undergraduate Research in Agricultural and Biological Engineering. Sem. 1 and 2. SS. Credit and hours to be arranged. Individual research projects for students with the approval of their advisors. Requires prior approval of, and arrangement with, a faculty research advisor. A written report and public oral presentation of final results are required. This course requires additional fees.

ABE 499H Honors Thesis Research. Sem. 1 and 2. SS. Prerequisite: admission to honors program. Credit and hours to be arranged. May be repeated for credit. Individualized research on agricultural and biological engineering problems. Arrange with honors program coordinator before registering. A written report and public oral presentation of final results are required. This course requires additional fees.

ABE 580 Process Engineering of Renewable Resouces. Sem. 2, Class 3, cr. 3. Prerequisite: CHM 102, MA 262. Physical and chemical structure of biomass. Reaction kinetics of hydrolysis of hemicellulose and cellulose to fermentable sugars. Fundamentals of ethanol production by fermentation. Separation of fermentation products into pure components.

ABE 590 Special Problems. Sem. 1 and 2. SS. Individual study 6, cr. 1-6. Assignment by consent of the instructor in the selected field of study. Laboratory, field, and library studies and reports on special problems related to agricultural and biological engineering not covered in regular coursework.

ABE 591Y Instrumentation and Data Acquisition. Sem. 1 and 2. SS. Class 2, lab. 1, cr. 3. Primarily designed for students (two or more) desiring credit from subject areas for which no specific course, workshop, or individual study plan is offered. Area of study will deal with topics that have enough student interest to justify the formalized teaching of a specialized topic. The course may be repeated by a student as long as the topic being taught is not repeated.

AGEC 406 Natural Resources and Environmental Economics. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: AGEC 217 or ECON 252. Introduction to economic models of renewable and nonrenewable natural resources and the use of these models in the analysis of current resource use and environmental issues. ***OR FNR 406***

AGEC 450 International Agricultural Trade. Sem. 1, Class 3, cr. 3. Prerequisite: AGEC 217. Study of U.S. agricultural trade with emphasis on international trade theory, exchange rates and their determination, relationships between domestic agricultural policies and trade policies, and analysis of institutional arrangements for world trade in agricultural products. ***OR NRES 450***

AGRY 540 Soil Chemistry. Sem. 1. Class 3, cr. 3. Prerequisite: AGRY 365 or consent of instructor. Emphasis on processes controlling the gaseous, solution, and solid phases in soils, including precipitation, acid-base, oxidation-reduction, complexation, absorption, and ion exchange.

AGRY 544 Environmental Organic Chemistry. Sem. 2. Class 3, cr. 3. Prerequisite: AGRY 255 and CHM 257, or consent of instructor. The fundamental properties and processes responsible for the fate of organic chemicals in the environment with emphasis on soil and water chemistry. Areas to be addressed will include both conceptual and theoretical aspects of processes relevant to environmental fate of contaminants; measurement, estimation, correlation, and application of the parameters most commonly used to assess various chemodynamic properties in soil-water systems.

AGRY 545 Remote Sensing of Land Resources. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: AGRY 105, and 255 or 270, or consent of instructor. Application of remote sensing and spatial data bases for observing and managing land resources within the Earth system; analysis and interpretation of remotely sensed data in combination with field observations and other data sources; conceptualization and design of a global earth resources information system.

AGRY 555 Soil and Plant Analysis. Sem. 2. Class 1, lab. 1, cr. 3. Prerequisite: a quantitative chemistry course or consent of instructor. Principles and methods of chemical analysis of plants and soils. Topics include soil carbon analysis, exchangeable cations, soil acidity, salinity, pesticide analysis, and elemental analysis of plant tissue. Quantitative gravimetric and columetric techniques are reviewed, followed by use of instrumental methods of analysis including atomic absorption, UV/Visible spectrometry, HPLC, and gas chromatography. Laboratory safety, quality assuranve/quality control, and data reporting are emphasized.

AGRY 560 Soil Physics. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: AGRY 255 or 270, and introductory physics. Fundamentals of soil physics; transport of chemicals, heat, and gases; field spatial variability; principles and methods of physical analysis of soils; the influence of soil physical processes on environmental quality and agricultural production.

AGRY 582 Environmental Fate of Pesticides. Sem. 2. Class 3, cr. 3. Emphasis is given to developing a fundamental understanding of the processes controlling the fate of organic chemicals, such as pesticides, in the environment. Processes considered include: volatilization, degradation, leaching, and sorption.

AGRY 585 Soils and Land Use. Sem. 2, Class 2, lab. 1, cr. 3. Prerequisite: 3 credit hours in Soil Sciences or 3 credit hours in Geological and Earth Sciences/Geosciences. Soils as a resource in development planning; soil properties affecting land use; use of soil survey, aerial photos, topographic maps, and other resource data in land-use allocation; nonengineering aspects of site selection for various land uses, water conservation, waste disposal, and erosion control.

ASM 211 Technical Graphics Communications. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite; ASM 231. Introduction to graphic communication methods using traditional techniques and emphasizing modern computer based techniques. Topics covered include: free-hand sketching, lettering, and dimensioning; selection of data presentation methods; and plan interpretation and cost calculations. A majority of assignments will include use of commercially available computer-aided drawing packages.

ASM 336 Environmental Systems Management. Sem. 1. Class 3, cr. 3. Analysis of environmental systems with special emphasis on non-urban and agribusiness needs. Technological and sociological solutions to environmental problems. Computer-based tools are used to analyze global environmental issues, chemical use, waste disposal and management, water and air quality, soil and water conservation, sustainable agriculture, regulatory and policy issues.

CE 350 Environmental Engineering. Sem. 1 and 2. SS. Class 3, cr 3. Prerequisite: CHM 116. Introduction to water pollution, air pollution, noise, hazardous and solid wastes, and their control. Environmental impact statements and global pollution issues. Field trips required.

CE 352 Biological Principles of Environmental Engineering. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite: completion of freshman engineering requirements. Introduction and application of environmental microbiological concepts to the solution of problems of water pollution and its control.

CE 353 Physico-chemical principles of Environmental Engineering. Sem.. Class 3, lab. 1, or class 2, lab. 3, cr. 4. Prerequisite: completion of freshman engineering requirements. This course presents basic physico-chemical aspects of air, water, and wastewater pollution, and pollution control methods. Topics covered in the course include acid/ base chemistry, solubility, colloidal chemistry, sorption processes, and oxidation-reduction. Selected physico-chemical processes and analytical procedures are discussed, demonstrated, and applied in the laboratory.

CE 440 Urban Hydraulics. Sem. 1. Class 3, cr. 3. Prerequisite: CE 340 or equivalent. Sources and distribution of water in urban environment, including surface reservoir requirements, utilization of groundwater, and distribution systems. Analysis of sewer systems and drainage courses for the disposal of both wastewater and storm water. Pumps and lift stations. Urban planning and storm drainage practice.

CE 457 Air Pollution Control and Design. Sem. 2. Class 3, cr. 3. Prerequisite: CE 340 or equivalent, or consent of instructor. Fundamental concepts and design procedures for the removal of particulates, gases, and toxic air pollutants from waste gas streams. Problem assessment; characterization of exhaust gas streams; fan characteristics.

CE 540 Open Channel Hydraulics. Sem. 1. Class 3, cr 3. Prerequisite: CE 340 or equivalent. Energy and momentum principles; design of open channels for uniform and non-uniform flow; boundary layer and roughness effects; flow-over spillways; energy dissipation; flow in channels of nonlinear alignment and non-prismatic section.

CE 542 Hydrology. Sem. 1. Class 3, cr. 3. Meteorology; precipitation stream flow, evaporation, and transpiration; ground water, subsurface flows, and well hydraulics; runoff relations and hydrographs; elements of stream flow routing, and frequency and duration studies; extreme values statistics applied to flood and drought forecasting; application of hydrologic techniques.

CE 544 Subsurface Hydrology. Sem. 2. Class 3, cr. 3. Prerequisite: CE 340 or consent of instructor. Basic principles of fluid flow in saturated and unsaturated materials. Darcy's law, well hydraulics, determination of hydraulic properties of aquifers. Infiltration theory. Discussions of artificial recharge, land subsidence, saltwater intrusion, ground water quality, and contamination.

CE 545 Sediment Transport Engineering. Sem. 1. Class 3, cr. 3. Prerequisite: a course in hydraulics or fluid mechanics. Sediment properties and the mechanics of sediment transport. Threshold of movement. River theory and stable channel design. River diversion problems. Erosion. Geomorphologic and water quality aspects.

CE 554 Aquatic Chemistry in Environmental Engineering. Sem. 1. Class 3, lab. 1, cr. 4. Corequisite: CHM 257 or equivalent. Principles of physical, quantitative, organic and inorganic chemistry applied to the analysis and distribution of the chemical composition of natural waters and engineered water systems. Lecture and laboratory topics include acid/base, complexation, precipitation/dissolution, sorption and redox reactions. Laboratory procedures include routine and advanced analytical techniques.

CE 559 Water Quality Modeling. Sem. 2. Class 3, cr. 3. Prerequisite: CE 352 and 554, or their equivalents. Mathematical modeling of chemical and biological processes occurring in natural aquatic systems. Classical oxygen demand and nutrient processes are modeled, as well as chemical specific transport and fate processes. Emphasis is placed on deterministic models, mass balance approaches, and chemical specific coefficients or parameters.

CE 593 Environmental Geotechnology. Sem. 2. Class 3, cr. 3. Prerequisite: CE 350 and 383 or consent of instructor. Review of regulations related to hazardous and solid waste disposal, including hazardous waste characterization. Discussion of contaminant transport in porous media and its relationship with remediation technologies for hazardous waste sites. Discussions of soil properties relative to waste containment systems, soil stability, and permeability.

CHE 540 Transport Phenomena. Sem. 1. Class 3, cr. 3. Prerequisite: CHE 378 or consent of instructor. Continuation of CHE 377 and 378. Topics in fluid mechanics, heat transfer, and mass transfer, including unsteady state transport problems, stream functions, potential flow, hydrodynamic and thermal layers, turbulence, and multi-component diffusion.

ECE 207 Electronic Measurement Techniques. Sem. 1 and 2. SS. Lab. 3, cr. 1. Prerequisite or corequisite: EE 201. Experimental exercises in the use of laboratory instruments. Voltage, current impedance, frequency, and wave form measurements. Frequency and transient response. Elements of circuit modeling and design.

FNR 103 Introduction to Environmental Conservation. Sem. 1 and 2. Class 3, cr. 3. Introduction to ecological principles, history of conservation, natural resource management, human impacts on the environment, and environmental ethics. For all students interested in an introductory natural resource or environmental science elective.

FNR 353 Natural Resources Assessment. Sem. 2, Class 2, lab. 1, cr. 3. Prerequisite: MA 224 and STAT 301. An introduction to sampling techniques and fundamental principles for measuring natural resources.

FNR 406 Natural Resource and Environmental Economics. Sem. 1. Class 3, cr. 3. Prerequisite: AGEC 217 or ECON 252. Introduction to economic models of renewable and nonrenewable natural resources and the use of these models in the analysis of current resource use and environmental issues. ***OR AGEC 406***

FNR 488 Global Environmental Issues. Sem. 1. Class 3, cr. 3. Examination of the state of the world in terms of natural resource consumption, environmental quality, and global change. Techniques to analyze and evaluate information. Survey threats to soil productivity, the changing atmosphere, water quality and quantity, energy impacts, and biodiversity from an ecosystem perspective.

FNR 558 Digital Remote Sensing and GIS. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: FNR 357 or consent of instructor. Advanced course in the use of digital remote sensing techniques and geographic information systems (GIS) for renewable natural resources management. Emphasizes the physical principles behind the digital remote sensing of vegetative features, present-day instrument technology, spatial data processing and analysis algorithms, error analysis and accuracy assessment procedures, and multi-source data integration. Provides hands-on experience with forest canopy modeling, atmospheric modeling, image processing, and GIS software on microcomputer and workstation platforms.

IE 343 Engineering Economics. Sem. 1 and 2. SS. Class 3, or class 2, rec. 1, cr. 3. Prerequisite: ENGR 126 and MA 166. Cost measurement and control in engineering studies. Basic accounting concepts, income measurement, and valuation problems. Manufacturing cost control and standard cost systems. Capital investment, engineering alternatives, and equipment replacement studies. Not open to students with credit in CE 394.

IE 370 Manufacturing Processes I. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: CE 273. Principal manufacturing processes; metal cutting, grinding and metal forming operations, machine tools, tools and tooling. Nontraditional machining and welding. Introduction to computer-aided manufacturing and computer-aided graphics and design, N/C programming, robots, and flexible manufacturing systems. Classroom and laboratory demonstrations included. Not open to students with credit in ME 363.

IE 577 Human Factors in Engineering. Sem. 1 and 2. Class 3, cr. 3. Survey of human factors in engineering, with particular reference to human functions in man-machine systems, and consideration of human abilities and limitations in relation to design of equipment and work environment.

ME 263 Introduction to Mechanical Engineering Design. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite: ME 200, 270, CGT 163; corequisite: MA 262, ME 290. The product design process. Development of product design specifications using customer inputs, benchmarking, product/market research and patent review. Concept generation and evaluation using brainstorming, functional decomposition, modeling and decision matrices. Detailed product design including assembly, economic analysis, CAD, and bill of materials. Oral and written design reviews. Key skills developed include teamwork, communication, project planning, innovation, design, and entrepreneurship.

ME 300 Thermodynamics II. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: ME 200 and 263. Properties of gas mixtures, air-vapor mixtures, applications. Thermodynamics of combustion processes, equilibrium. Energy conversion, power, and refrigeration systems.

ME 315 Heat and Mass Transfer. Sem. 1 and 2. SS. Class 3, lab. 1, or class 3, lab. 1, practice 1, cr. 4. Prerequisite: ME 309 and 365 and MA 303. Fundamentals of heat transfer by conduction, convection, and radiation; mass transfer by convection. Relevance to engineering applications.

ME 365 Systems and Measurements. Sem. 1 and 2. SS. Class 2, lab. 1, cr. 3. Prerequisite: ECE 201 and 207, ME 274, and MA 262. The fundamentals of dynamic system modeling are reviewed, with special reference to measurement systems. Introduction to engineering measurement fundamentals, including digital and frequency domain techniques, noise, and error analysis.

ME 375 System Modeling and Analysis. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: ME 365 and MA 303. Introduction to modeling electrical, mechanical, fluid, and thermal systems containing elements such as sensors and actuators used in feedback control systems. Dynamic response and stability characteristics. Closed loop system analysis including proportional, integral, and derivative elements to control system response.

ME 413 Noise Control. Sem. 2. Class 3, cr. 3. Prerequisite: Course work in Physics, General; Course work in differential equations. Fundamentals of acoustic waves. Psychoacoustics and theories of hearing. Environmental and building acoustics. Measurement methods and common instrumentation. Noise control methods. Machinery noise. Community reaction. Legal aspects. Design-oriented semester project.

ME 418 Engineering of Environmental Systems and Equipment. Sem. 2. Class 3, cr. 3. Prerequisite: ME 300 and 315. Design and analysis of systems and equipment used in conditioning buildings. Review of fundamentals in thermodynamics, heat transfer, fluid mechanics, economics, non-linear equation solving, optimization. Analysis of building heating and cooling requirements for design and annual energy use. Design and selection of equipment.

ME 430 Power Engineering. Sem. 1. Class 3, cr. 3. Prerequisite: first course in thermodynamics. Rankine cycle analysis, fossil-fuel steam generators, energy balances, fans, pumps, cooling towers, steam turbines, availability (second law) analysis of power systems, energy management systems, and rate analysis.

ME 440 Internal Combustion Engines. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: ME 300; corequisite: ME 315. Application of thermodynamics, fluid mechanics and heat transfer to processes in internal combustion engines. Intake and exhaust processes in engines. Spark-ignition (SI), compression-ignition (CI), and alternate engines. Discussion of engine design and performance to complement lectures. Laboratory work on SI and CI engines. Current challenges facing engine designers.

ME 475 Automatic Control Systems. Sem. 1 and 2. Class 2, lab. 1, cr. 3. Prerequisite: ME 375. Controller design in frequency domain with introduction to digital systems and control.

MSE 230 Structure & Properties of Materials. Sem. 1 and 2. Class 2, rec. 1, cr. 3. Prerequisite: CHM 115 and MA 165. The relationship between the structure of materials and the resulting mechanical, thermal, electrical, and optical properties. Atomic structure, bonding, atomic arrangement; crystal symmetry, crystal structure, habit, lattices, defects, and the use of X-ray diffraction. Phase equilibria and microstructural development. Applications to design.

NRES Soil Conservation and Water Management. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: AGRY 270 or NRES 255. Principles of soil conservation with emphasis on control of soil erosion by wind and water; impact of soil management decisions on environment; soil-water-plant relations, includes agronomic aspects of water management for both irrigation and drainage. ***OR AGRY 450***

STAT 511 Statistical Methods. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: MA 162. Descriptive statistics; elementary probability; sampling distributions; inference, testing hypotheses, and estimations; normal, binomial. Poisson, hypergeometric distributions; one-way analysis of variance; contingency tables; regression. Credit cannot be given for more than one of STAT 301, 305, 350, 433, 501, or 511.

STAT 512 Applied Regression Analysis. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: STAT 503 or 511 or 517. Inference in simple and multiple linear regression, residual analysis, transformations, polynomial regression, model building with real data, nonlinear regression. One-way and two-way analysis of variance, multiple comparisons, fixed and random factors, analysis of covariance. Use of existing statistical computer programs.

Agricultural & Natural Resources Engineering Record -- students entering Fall 2006 –

Name _____ **Area of Specialization:** ❑ **MSE** ❑ **ENRE**

Math & Sciences (33/34 cr)	Sem/Yr	Grade
CHM 115 (4)		
CHM 116 (4) Required for ENRE Option for MSE		
CS 159 (3) Option for MSE		
ENGR 126 (3)		
MA 165 (4)		
MA 166 (4)		
MA 261 (4)		
MA 262 (4)		
PHYS 172 (4)		
PHYS 241 (3)		

Communications (7 cr)		
COM 114 (3)		
ENGL 106 (4)		

Biological Sciences (8 cr)		
(4)		
(4)		

School of Agriculture (6 cr)		
AGRY 255 (3)		
Elec (3)		

Other Electives (7 cr if CHM 116 taken – 8 cr if CS 159 taken)		

Engineering (min 48 cr)	Sem/Yr	Grade
ABE 205 (3)		
ABE 210 (3)		
ABE 305 (3)		
ABE 325 (4)		
ABE 330 (3)		
ABE 435 (3)		
ABE 450 (3)		
ABE 485 (4)		
NUCL 273 (3)		
CE 340(3) & CE343(1) or ME309 (4)		
ECE 201 (3)		
ME 270 (3)		
ME 274 (3)		
Elec (3)		
Elec (3)		

General Education Electives (18 cr) ***[3 cr @ 300+]***		
Social Science (6 cr min)		
Econ Elec (3) – 251 / 252		
(3)		
Humanities (6 cr min)		
(3)		
(3)		
SS/Hum		
Written/Oral Com (3) –		
(3)		

Other (3 cr)		
AGR 101 / ENGR 100 (1)		
ABE 290 (1)		
ABE 490 (1)		

Total credits required for graduation = 131

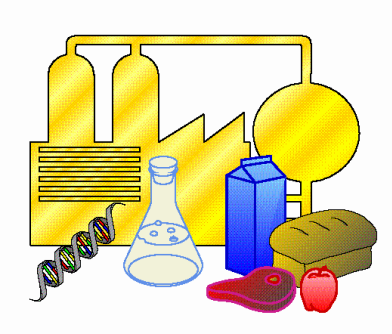
Math/Sci	(33/34)	_____
Com	(7)	_____
Biol Sci	(8)	_____
Ag	(6)	_____
Other Elec	(7/8)	_____
Engr	(48)	_____
Hum/SS	(18)	_____
Other	(3)	_____
Total credits earned		_____

International Understanding (6 cr) _____ _____

Multicultural Awareness (3) _____

Final Audit Completed	Signature	Date
Student Svcs Coord	_____	_____
Advisor	_____	_____

Biological and Food Process Engineering



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.

Biological and Food Process Engineers apply basic scientific and engineering principles to products and processes involving biological and food systems, such as:

- research and development of new foods, biological and pharmaceutical products
- development and operation of manufacturing, packaging and distributing systems for drug/ food products
- design and installation of food/biological/pharmaceutical production processes
- design and operation of environmentally responsible waste treatment systems
- marketing and technical support for manufacturing plants.

The Biological and Food Process Engineering (BFPE) program leads to an ABET-accredited B.S. degree from the College of Engineering. The Biological and Food Process Engineering curriculum includes basic science courses (Biology, Chemistry, Physics) as well as organic, physical, and food chemistry. Courses in engineering involve thermodynamics, kinetics, unit operations, and engineering design and cover both theoretical and practical aspects of engineering analysis and design. In the senior year, you will have the opportunity to apply your knowledge to the solution of actual food, biological and pharmaceutical processing problems. You will learn about designing unit operations, such as extrusion, emulsification, heat exchangers, sheeting, sterilization, aseptic processing, freezing, membrane separations, protein purification, evaporation, extraction, fermentation, and packaging, and integrate these with process design principles to design fermentation, enzymatic, and food products/ processes. Employment and career advancement opportunities have been excellent for graduates, not only nationally, but also internationally.

Dual degree programs involving Biochemistry or Pharmaceutical Sciences result in two degrees, one in engineering and one in either biochemistry or pharmaceutical sciences. This would require an additional year of courses. These degrees are focused, intense programs of study targeted to provide graduates with unique skills and job opportunities to take on roles of technical leadership in biological engineering in the next century.

For example, genetic engineering of foods and pharmaceuticals is a target growth technology for the next century involving the manipulation of the genes of microbial, plant, insect and animal cells to alter their processing and product capacities. The dual degree programs are highly interdisciplinary and prepare graduates with an excellent combination of scientific and engineering skills to work in industries involving state-of-the-art technologies such as genetic engineering.

While classes and grades are very important, there are many other important skills to learn at a university. These programs also include education in interpersonal management and communications skills, such as interviewing techniques, leadership training, management supervision opportunities, professional development and much more. An internship or coop experience is not required, but is highly recommended. Overall, a well-rounded education is the best way to plan for your future.

Dual-Degrees

ABE BFPE / Biochemistry
ABE BFPE / Pharmaceutical Sciences

Biological and Food Process Engineering Plan of Study

(Students entering Fall 2006 and after)

(Credit Hours Required for Graduation: 133)

Freshman Year (ABE 120, Introduction to Ag & Biological Engineering, is recommended for the Freshman year.)

First Semester				Second Semester			
1	AGR 101 Freshman Engineering Lectures			4	CHM	116	General Chemistry II
	OR ENGR 100 Freshman Engineering Lectures			3	COM	114	Fundamentals of Speech Communications
4	CHM	115	General Chemistry I	4	MA	166	Plane Analytic Geometry and Calculus II
4	ENGL	106	English Composition I	4	PHYS	172	Modern Mechanics
3	ENGR	126	Engineering Problem Solving and Computer Tools	3			Humanities/Social Science Elective
4	MA	165	Plane Analytic Geometry and Calculus I				
16				18			

Sophomore Year

Third Semester				Fourth Semester			
3	ABE	201	Thermodynamics of Biological Systems I	3	ABE	202	Thermodynamics of Biological Systems II
1	ABE	290	Sophomore Seminar	3	BCHM	221	Analytical Biochemistry **OR** F&N 205 Food Science
4	MA	261	Multivariate Calculus	3	MA	265	Linear Algebra
4	CHM	257	Organic Chemistryl	3	MA	266	Ordinary Differential Equations
3	PHYS	241	Electricity and Optics	3			Engineering Elective (IE 343 recommended)
3			General Education elective **	3			General Education Elective**
18				18			

Junior Year

Fifth Semester				Sixth Semester			
3	ABE	303	App of Phys Chemistry to Biol Processes	4	BIOL	221	Microbiology
3	ABE	301	Modeling & Computation Tools in Biological Engineering	3	ABE	370	Biological/Microbial Kinetics and Reaction Engineering
3	CHE	377	Momentum Transfer	3	CHE	378	Heat and Mass Transfer
3	BIOL	230	Biology of the Living Cell	4	ABE	454	Transport Processes in Biological and Food Process Systems
1	BIOL	295F	Quantitative Biology of the Living Cell				
3			General Education Elective **	3			Engineering Elective (CHE 320 recommended)
16				17			

Senior Year

Seventh Semester				Eighth Semester			
1	ABE	490	Professional Practice in Agricultural and Biological Engineering	3	ABE	580	Process Engineering of Renewable Resources
				4	ABE	556	Biological and Food Process Design
4	ABE	555	Biological and Food Processing Unit Operations	3	ABE	460	Sensors and Process Controls
3			Biological or Food Science Elective ††	3			General Education Elective**
3			Engineering Elective††	3			Biological or Food Science Elective††
3			General Education Elective**				
14				16			

*** Eighteen credit hours of general education electives must be chosen in accordance with the general education document (available in the Student Academic Center, ABE 201). Of the 18 credit hours, 3 must be Economics (ECON 251 or 252), and 3 must be an additional Communication elective.*

†† Restricted elective. See list of approved courses in the ABE Student Handbook. Updated 5/2/07

Selectives: FS 361, FS 362, FS 453, FS 467, F&N 315, F&N 534

Dual Degree -- Biochemistry / ABE Biological and Food Process Engineering

Credit Hours Required for Graduation: 168

Freshman Year

First Semester

1	ENGR	100	Freshman Engineering Lectures/ OR
		AGR 101	Agriculture Lectures
4	CHM	115	General Chemistry I
4	ENGL	106	English Composition I
3	ENGR	126	Engineering Problem Solving and Computer Tools
4	MA	165	Analytic Geometry & Calculus I
3	HUM SS Elective (Liberal Arts)		
19			

Second Semester

4	CHM	116	General Chemistry II
3	COM	114	Fundamentals of Speech Communication
4	MA	166	Analytic Geometry & Calculus II
4	PHYS	172	Modern Mechanics
15			

Sophomore Year

Third Semester

3	ABE	201	Thermodynamics of Biological Systems I
2	BIOL	121	Biology I: Diversity, Ecology, & Behavior
4	MA	261	Multivariate Calculus
3	PHYS	241	Electricity and Optics
3	HUM SS Elective (Liberal Arts)		
1	ABE	290	Sophomore Seminar
16			

Fourth Semester

3	ABE	202	Thermodynamics of Biological Systems II
2	BIOL	131	Biology II: Dev., Structure, & Function of Organisms
3	Engineering Elective		
3	MA	265	Linear Algebra
3	MA	266	Ordinary Differential Equations
3	BCHM	221	Analytical Biochemistry
17			

Junior Year

Fifth Semester

3	ABE	303	Physical Properties of Biological Materials
3	BIOL	230	Biology of the Living Cell
1	BIOL	295F	Quantitative Biology of the Living Cell
3	CHE	377	Momentum Transfer
3	CHM	261	Organic Chemistry
1	CHM	263	Organic Chemistry Lab
3	HUM SS Elective**(International Understanding)		
17			

Sixth Semester

3	CHE	378	Heat and Mass Transfer
3	CHM	262	Organic Chemistry
1	CHM	264	Organic Chemistry Lab
4	CHM	372	Physical Chemistry
3	HUM SS Elective**(International Understanding)		
3	HUM SS Elective		
17			

Senior Year

Seventh Semester

3	ABE	301	Thermodynamics of Food & Biological Systems
3	AGRY	320	Genetics
1	AGRY	321	Genetics Laboratory
2	BCHM	322	Analytical Biochemistry
3	BCHM	561	General Biochemistry
3	Engineering Elective (IE 343 recommended)		
3	HUM SS Elective (Addl Com Elective)		
18			

Eighth Semester

3	ABE	370	Biological/Microbial Kinetics & Reaction Engr
4	ABE	454	Transport Processes in Biological & Food
3	BCHM	562	General Biochemistry II
3	CHE	320	Statistical Modeling and Quality Control
3	HUM SS Elective (Economics - ECON 252)		
16			

Senior Year (Fifth Year)

Ninth Semester

1	ABE	490	Professional Practice in Ag & Bio Engineering
4	ABE	555	Biological & Food Processing Unit Operations
3	BIOL	438	General Microbiology
3	BIOL Elective		
3	BCHM	572	Advanced Biochemical Tech
3	HUM SS Elective (Liberal Arts)		
17			

Tenth Semester

4	ABE	556	Food Plant Design
2	BCHM	565	Biochemistry of Life Processes
3	HUM SS Electives (Liberal Arts)		
3	ABE	580	Bioprocess Engineering-Renewable Resources
3	ABE	460	Sensors and Process Control
1	BCHM	490	Undergraduate Seminar
16			

* See list of College of Engineering approved HUM-SS courses & College of Ag International Understanding Electives

Selectives: AGR 320/321, BCHM 221, BCHM 561, BCHM 562, BIOL 341/342

Dual Degree - Pharmaceutical Sciences / ABE Biological and Food Process Engineering

Credit Hours Required for Graduation: 178

Freshman Year

First Semester				Second Semester			
1	ENGR	100	Freshman Engineering Lectures/ OR	4	CHM	116	General Chemistry II
			AGR 101 Ag Lectures / OR	3	COM	114	Fundamentals of Speech Communication
			IPPH 100 Pharmaceutical Sciences Orientation	4	MA	166	Analytic Geometry & Calculus II
4	CHM	115	General Chemistry I	4	PHYS	172	Mechanics
4	ENGL	106	English Composition I	3			Humanities/Social Science Elective
3	ENGR	126	Engineering Problem Solving and Computer Tools				
4	MA	165	Analytic Geometry & Calculus I				
3	HUM SS Elective						
19				18			

Sophomore Year

Third Semester				Fourth Semester			
3	ABE	201	Thermodynamics of Biological Systems I	3	ABE	202	Thermodynamics of Biological Systems II
4	BIOL	110	Biology	4	BIOL	111	Biology
4	MA	261	Multivariate Calculus	4	MA	262	Linear Algebra and Differential Equations
4	MCMP	204	Organic Chemistry	4	MCMP	205	Organic Chemistry II
1	ABE	290	Sophomore Seminar	3	PHYS	241	Electricity and Optics
16				18			

Junior Year

Fifth Semester				Sixth Semester			
3	ABE	303	Physical Properties of Biological Materials	4	BIOL	221	Microbiology
3	BIOL	301	Anatomy and Physiology	3	BIOL	302	Anatomy and Physiology
3	CHE	377	Momentum Transfer	3	CHE	320	Statistical Modeling & Quality Enhancement
3	MCMP	304	Biological Chemistry I	3	CHE	378	Heat and Mass Transfer
3	Engineering Elective (IE 343)			3	MCMP	305	Biological Chemistry II
3	HUM SS Elective (Economics)			3	HUM SS Elective (International)		
18				19			

Senior Year

Seventh Semester				Eighth Semester			
3	ABE	301	Thermodynamics of Biological & Food Systems	4	ABE	454	Transport Processes in Biological & Food Process Systems
4	CHM	321	Analytical Chemistry	3	ABE	370	Biological/Microbial Kinetics & Reaction Engr
3	IPPH	362	Basic Pharmaceutics I	3	IPPH	363	Basic Pharmaceutics II
3	IPPH	562	Manufacturing Processes	3	MCMP	422	Immunology and Biologics
3	Engineering Elective			3	MCMP	440	Pathophysiology
3	HUM SS Elective						
19				16			

Senior Year

Ninth Semester				Tenth Semester			
1	ABE	490	Professional Practice in Ag & Bio Engineering	3	ABE	460	Sensors and Process Control
4	ABE	555	Biological & Food Process Unit Operations	4	ABE	556	Food Plant Design & Economics
3	MCMP	407	Medicinal Chemistry & Molecular Pharmacology I	3	IPPH	475	Biopharmaceutics
3	MCMP	441	Medicinal Chemistry & Molecular Pharmacology II	2	MCMP	408	Medicinal Chemistry & Molecular Pharmacology III
3	Engineering Elective			3	MCMP	442	Medicinal Chemistry & Molecular Pharmacology IV
3	HUM SS Elective			3	ABE	580	Bioprocess Engineering-Renewable Resources
17				18			

Selectives: IPPH 362, IPPH 363, IPPH 562

Summer Internship Program through Pharmaceutical Sciences (requires Maymester course prior to Industry Experience)

Biological and Food Process Engineering - Engineering Electives

The Biological and Food Process Engineering curriculum contains 12 credits of courses labeled ENGINEERING TECHNICAL ELECTIVE. Below is a list of approved engineering courses which can be used to satisfy the footnote associated with those ELECTIVES. Other engineering courses can be selected but must be reviewed for acceptance on an individual basis. *See your academic advisor for additional assistance.*

Course	Title	Course	Title
ABE 330	Design of Machine Components	ECE 266	Digital Logic Design
ABE 435	Hydraulic Control Systems for Mobile Eqpt	ECE 520	Topics in Biomedical Engineering
ABE 450	Finite Element Method in Design and Opt.	ECE 522	Problems in the Measurement of Physiological Events
ABE 495	Select Topics in Ag & Biol Engineering	IE 230	Probability and Statistics in Engineering I
ABE 498	Undergraduate Research in Ag & Biol Engr	**IE 330	Probability and Statistics in Engineering II
ABE 499H	Honors Thesis Research	IE 343	Engineering Economics
*ABE 580	Process Engineering of Renewable Resources	*IE 370	Manufacturing Processes I
CHE 306	Design of Staged Separation Processes	IE 383	Integrated Production Systems I
CE 350	Environmental Engineering	IE 577	Human Factors in Engineering
**CHE 320	Statistical Modeling & Quality Enhancement	ME 270	Basic Mechanics I
CHE 461	Biomedical Engineering	ME 300	Thermodynamics II
CHE 540	Transport Phenomena	ME 418	Engineering of Environmental Systems and Equipment
*ECE 201	Linear Circuit Analysis I	MSE 230	Structure and Properties of Materials
ECE 207	Electronic Measurement Techniques	*NUCL 273	Mechanics of Materials

*recommended
**highly recommended

Biological and Food Process Engineering - Food Science Electives

The Biological and Food Process Engineering curriculum contains *3 credits* labeled FOOD SCIENCE ELECTIVE. Below is a list of approved courses which can be used to satisfy those elective credits.

Please note: a TOTAL of 3 credits are required.

ANSC 481	Contemporary Issues in Animal Sciences	1 cr	FS 453	Food Chemistry	
FS 361	Food Plant Sanitation	1 cr	FS 551	Magnetic Resonance for Food and Agricuture	
FS 362	Food Microbiology	2 cr	FS 541	Postharvest Technology of Fruit & Vegetables	1 cr
FS 444	Statistical Process Control	1 cr	F&N 205	Food Science I	3 cr
FS 467	Food Analysis	4 cr	F&N 315	Fundamentals of Nutrition	3 cr
FS 363	Food Microbiology Laboratory		F&N 534	HumanSensory Systems and Food Evaluation	3 cr

Biological and Food Process Engineering Course Descriptions

Required Courses (Catalog Descriptions)

ABE 201 Thermodynamics in Biological Systems I. Sem. 1. Class 3, cr. 3. Prerequisite: CHM 116 or 124. Thermodynamic principles associated with biological systems and processing of biological materials. Emphasis on the first law of thermodynamics. Fundamentals of steady-state mass and energy balances for reacting and non-reacting processes including multiple unit operations emphasizing living systems and bio-processing. Applications of the first law conservation of energy to biological systems, energy conversion systems, and the environmental impacts of energy production. Development of engineering problem solving skills via MathCad and MatLab software.

ABE 202 Thermodynamics in Biological Systems II. Sem. 2. Class 3, cr. 3. Prerequisite: ABE 201 and MA 261. Thermodynamic principles and their applications to biochemical and biological systems with emphasis on the second law of thermodynamics and use of molecular interpretations of energies and entropies. Concept of entropy balances and process efficiency. Free energy and chemical equilibrium. Equilibrium between phases, colligative properties, binding of ligands and formation of biological membranes. Molecular motion and transport properties and their application in biochemical analytical methods. Development of physical chemical problem solving skills using MathCad and MatLab software.

ABE 290 Sophomore Seminar. Sem. 1. Class 2, cr. 1. 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.

ABE 301 Modeling and Computational Tools. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: MA 265, 266, or ABE 202, MA 262. Introduction to principles of analysis, setup, and modeling of biological systems using fundamental principles of engineering. Development of algebraic and differential models of steady state and transient processes involving material and energy balances, elementary thermodynamic, transport, and kinetic reaction principles, and economics in biological engineering systems.

ABE 303 Applications of Physical Chemistry to Biological Processes Sem. 1. Class 3, cr. 3. Prerequisite: ABE 210 and CHM 257. Corequisite: CHE 377. Physical chemical principles associated with transport of mass, momentum and energy in bioprocesses. Measuring principles of physical chemical properties, a description of predictive equations for their evaluation and the role of these principles in the design and optimization of bioprocesses.

ABE 370 Biological/Microbial Kinetics and Reaction Engineering. Sem. 2. class 3, cr. 3. Prerequisite: ABE 310, CHM 257, MA 265, 266. Corequisite: BIOL 221. Study of the rates of chemical/biochemical reaction and catalysis in agricultural, food, and biological systems with applications to engineering process design. Applications include microbial growth, enzyme catalysis, fermentation and reactor design. Introductory enzymatic and microbial reaction concepts will be taught and incorporated into reactor design.

ABE 454 Transport Processes in Biological and Food Process Systems. Sem. 2. class 3, lab. 1, cr. 4. Prerequisite: CHE 377. Corequisite: CHE 378. Application of momentum and heat transfer to biological and food process engineering. Viscosity, Non-Newtonian fluids, experimental methods of rheological characterization of food and biological systems; viscoelasticity; design equations for pipeflow, pumps, mixing, emulsification, extrusion, sheeting, heat exchangers, aseptic processing, unsteady state heat transfer, sterilization, freezing, evaporation.

ABE 460 Sensors and Process Control. Sem. 2. class2, lab. 1, cr. 3. Prerequisite: differential equations and a course in either heat transfer or fluid mechanics. Fundamental aspects of transducers, biosensors, instrumentation and computer control are presented with particular emphasis on sensors and controls used in agricultural, biological and food applications. Laboratory and pilot plant scale computer controlled equipment is used to examine response of process variables, sensor calibration, control system modeling and controller selection and tuning.

ABE 490 Professional Practice in Agricultural and Biological Engineering. Sem. 1. Lab. 2, cr. 1. Career areas in agricultural engineering; job opportunities and graduate study; professional attitudes and ethics; contracts and specifications; patents.

ABE 555 Biological and Food Process Unit Operation. Sem. 1. Class 3, lab. 1, cr. 4. Prerequisite: CHE 378 Analysis and design of unit operations such as drying and sterilization. The principles of thermodynamics, heat transfer, mass transfer, fluid flow, and food science will be applied in designing food-processing systems.

ABE 556 Biological and Food Process Design. Sem. 2. Class 3, lab. 1., cr. 4. Prerequisite: ABE 555. The course will focus on the synthesis, creation, evaluation and optimization of a preliminary process design to convert basic biological materials into a finished product. Concepts of materials and energy balances, thermodynamics, kinetics, transport phenomena of biological systems will be used to design processes to minimize energy and environmental impacts, and evaluate economic factors while maintaining product quality. Group projects, written and oral reports.

ABE 580 Process Engineering of Renewable Resources. Sem. 2. Class 3, cr. 3. Prerequisite: CHM 102, MA 262. Physical and chemical structure of biomass. Reaction kinetics of hydrolysis of hemicellulose and cellulose to fermentable sugars. Fundamentals of ethanol production by fermentation. Separation of fermentation products into pure components.

AGR 101 Introduction to the College of Agriculture and Purdue University. Sem. 1. Class 1, presentation 1, cr. 1. Course meets during weeks 1-8. Students are introduced to the College of Agriculture and Purdue University. Specific areas discussed include the diversity of career opportunities within agriculture, the relationship between different areas of Agriculture, ethics, the impact of undergraduate coursework, including the core curriculum, on scholarship and career preparation, and the challenges facing the food, agricultural, and natural resource system. The use of guest lectures provides a networking opportunity for students. ***OR ENGR 100***

BCHM 221 Analytical Biochemistry. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: CHM 116. Discussion of qualitative and quantitative analysis of biological compounds including pH measurement and control, spectrophotometry, measurement of radioactivity; theoretical basis of various separation techniques, including chromatography and electrophoresis; application of these methods to separation and analysis of biological compounds. Laboratory sessions will provide practical experience in the use of these methods. This course is designed for biochemistry majors. ***OR F&N 205***

BIOL 221 Introduction to Microbiology. Sem. 1 and 2. Class 3, lab. 1, cr. 4. Prerequisite: one year of general chemistry and one semester of a life science. The isolation, growth, structure, function, heredity, identification, classification, and ecology of microorganisms; their role in nature; and significance to man. Does not satisfy requirements for biology majors.

BIOL 230 Biology of the Living Cell. Sem. 1. Class 3, cr. 3. Prerequisites: CHM 115/116, MNA 223, 224, or 161, 162. An introduction to modern cell biology for students who may not have taken a previous college course in biology. All students with the appropriate prerequisites are welcome, and this course will be of special interest to students from engineering, chemistry, physics and computer science. This course will provide a solid foundation in modern cell biology concepts for engineers and students from other disciplines.

BIOL 295F Quant Biology Living Cell. Sem. 1 and 2. SS. Lab. 1, cr. 1. Reading, discussions, written reports, or laboratory work selected for enrichment in special areas of the biological sciences.

CHE 377 Momentum Transfer. Sem. 1. Class 3, cr. 3. Prerequisite: CHE 205 and MA 266. Corequisite: CHE 211, MA 303. Differential (microscopic) and integral (macroscopic) mass momentum, and energy balances. Newtonian and non-Newtonian fluids. Fluid statics. One-dimensional steady and transient laminar flows. Turbulence. Dimensional analysis and similarity. Friction factors and drag coefficients. Applications to engineering analysis of practical problems. Introduction to numerical analysis and visualization of flows.

CHE 378 Heat and Mass Transfer. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: CHE 211 and 377. Macroscopic and differential energy balances. Heat transfer coefficients for free and forced convection and phase change. Conductive and radiative heat transfer. Applications to heat transfer equipment design and compressible fluid flow. Macroscopic and differential species balances. Mass transfer coefficients and analogies. Mass transfer with and without chemical reaction. Mass transfer equipment design.

CHM 115 General Chemistry. Sem. 1 and 2. SS. Class 2, lab. 1, rec. 1, cr. 4. Prerequisite: MA 159. Corequisite: MA 161 or 223. Stiochiometry; 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 123.

CHM 116 General Chemistry. Sem. 1 and 2. SS. Class 2, lab. 1, rec. 1, cr. 4. Prerequisite: CHM 115. A continuation of CHM 115. Solutions; quantitative equilibria in aqueous solution; introductory thermodynamics; oxidation-reduction and electro-chemistry; chemical kinetics; qualitative analysis; further descriptive chemistry of metals and nonmetals.

CHM 257 Organic Chemistry. Sem. 1 and 2. Class 3, rec. 1, cr. 4. Prerequisite: CHM 112 or 116. Introductory organic chemistry. Emphasis is on structure, nomenclature, reactions, and theory as applied to simple organic compounds. This is a more rigorous one-semester course than CHM 251 and is designed for students who may be planning to take additional chemistry, especially biochemistry.

COM 114 Fundamentals of Speech Communication. Sem. 1 and 2. SS. Class 3, cr. 3. 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

ECON 251 Microeconomics. Sem. 1 and 2. SS. Class 3, cr. 3. Price theory and resource allocation. Emphasis is on developing a detailed understanding of the principles of microeconomic analysis and their application to market behavior and public policy issues. ***OR ECON 252***

ECON 252 Macroeconomics. Sem. 1 and 2. SS. Class 3, cr. 3. Introduction to macroeconomic theory. The course develops a theoretical framework permitting an analysis of the forces affecting national income, employment, interest rates, and the rate of inflation. Emphasis is placed upon the role of government fiscal and monetary policy in promoting economic growth and stable prices. ***OR ECON 251***

ENGL 106 First-Year Composition. Sem. 1 and 2. SS. Class 3, rec. 1, cr. 4. Prerequisite: 6 credit hours at the lower division undergraduate level in Education, General. Extensive practice in writing clear and effective prose. Instruction in organization, audience, style, and research-based writing.

ENGR 100 Freshman Engineering Lectures. Sem. 1 and 2. Class 1, cr. 1 (Available pass/not-pass only.) An introduction to the engineering profession. ***OR AGR 101***

ENGR 126 Engineering Problem Solving and Computer Tools. Sem. 1 and 2. SS. Corequisite: MA 165. Introduction to the solving of open-ended engineering problems and the use and of computer software, including UNIXTM, computer communications, spreadsheets, and MATLAB. Explicit model-development activities are utilized, and students are expected to develop skill at working in teams. This is emphasized both in laboratories and on projects.

F&N 205 Food Science I. Sem. 1 and 2. Class 1, lab. 1, cr. 3. Prerequisite: CHM 112. Chemical and physical composition of foods: their changes during processing, storage, and preparation. ***OR BCHM 221***

MA 165 Analytic Geometry and Calculus I. Sem. 1 and 2. Class 3, rec. 1, cr. 4. Prerequisite: Demonstrated competency in college algebra and trigonometry at the level of MA 151. 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 162 or 166. Introduction to differential and integral calculus of one variable, with applications. Conic sections.

MA 166 Plane Geometry and Calculus II. Sem. 1 and 2. Class 3, rec. 1, cr. 4. Prerequisite: MA 165. Continuation of MA 165. 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 162.

MA 261 Multivariate Calculus. Sem. 1 and 2. SS. Class 3, rec. 1, cr. 4. Prerequisite: MA 162 or 166. Not open to students with credit in MA 174 or 271. Planes, lines, and curves in three dimensions. Differential calculus of several variables; multiple integrals. Introduction to vector calculus.

MA 265 Linear Algebra. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: MA 162, 166, or 173. Not open to students with credit in MA 262, 272, 350, or 351. Introduction to linear algebra. Systems of linear equations, matrix algebra, vector spaces, determinants, eigenvalues and eigenvectors, diagonalization of matrices, applications.

MA 266 Ordinary Differential Equations. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: MA 261. (It is preferable but not required to take MA 265 either first or concurrently.) Not open to students with credit in MA 262, 272, 360, 361, or 366. First order equations, second and n'th order linear equations, series solutions, solution by Laplace transform, systems of linear equations.

PHYS 172 Modern Mechanics. Sem. 1 and 2. SS. Class 2, lab. 1, rec. 1, cr.4. Corequisite: MA 161. 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.

PHYS 241 Electricity and Optics. Sem. 1 and 2. SS. Class 2, rec. 2, cr. 3. Prerequisite: PHYS 172. Electrostatics, current electricity, electromagnetism, magnetic properties of matter. Electromagnetic waves, geometrical and physical optics.

Elective Courses (Catalog Descriptions)

ABE 281 Professional Internship. Sem. 1 and 2. SS. Cr. 0. Supervised professional experience in Agricultural and Biological Engineering. Program conducted under the direction of an engineering faculty member and cooperation of an employer. Students submit a summary report.

ABE 330 Design of Machine Components. Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: NUCL 273. 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.

ABE 435 Hydraulic Control Systems for Mobile Equipment. Sem. 1. Class 2, lab. 1, cr. 3. Prerequisite: CE 340 or ME 309. Design of basic fluid power components and systems. Includes power steering, hydrostatic and hydromechanical transmission, electrohydraulic servovalves, servomechanism, and manually controlled systems.

ABE 450 Finite Element Method in Design and Optimization. Sem. 1. Class 3, cr. 3. Prerequisite: ABE 330. Fundamentals of the finite element method as it is used in modeling, design and optimization of different mechanical systems; one- and two-dimensional elements and field problems; heat transfer and fluid flow problems; beam, truss, and frame elements; computer-aided design of machine components and structural elements.

ABE 495 Select Topics in Agricultural and Biological Engineering. Sem. 1 and 2. SS. Cr. 1-3. Credit and hours to be arranged. Special topics and projects of contemporary importance or of special interest that are outside the scope of the standard agricultural and biological engineering curriculum. The specific topic that is offered will be indicated on the student's record. A written report and oral presentation of final results are required.

ABE 498 Undergraduate Research in Agricultural and Biological Engineering. Sem. 1 and 2. SS. Credit and hours to be arranged. May be repeated for credit. Individual research projects for students with the approval of their advisors. Requires prior approval of, and arrangement with, a faculty research advisor. A written report and public oral presentation of final results are required. This course requires additional fees.

ABE 499H Honors Thesis Research. Sem. 1 and 2. SS. Cr. 1-6. Prerequisite: admission to honors program. Credit and hours to be arranged. May be repeated for credit. Individualized research on agricultural and biological engineering problems. Arrange with honors program coordinator before registering. A written report and public oral presentation of final results are required.

ABE 580 Bioprocess Engineering of Renewable Resources. Sem. 2. Class 3, cr. 3. Prerequisite: CHM 102, MA 262. Physical and chemical structure of biomass. Reaction kinetics of hydrolysis of hemicellulose and cellulose to fermentable sugars. Fundamentals of ethanol production by fermentation. Separation of fermentation products into pure components.

ANSC 481 Contemporary Issues in Animal Sciences Sem. 1. Class 1, cr. 1. Student-led discussion and debate of current issues facing animal industries to include environmental impact, food safety, animal care and well-being, ethics, use of biotechnology, world food supply, and international agricultural trade issues.

CE 350 Environmental Engineering. Sem. 1 and 2. SS. Class 3, cr 3. Prerequisite: CHM 116. Introduction to water pollution, air pollution, noise, hazardous and solid wastes, and their control. Environmental impact statements and global pollution issues. Field trips required.

CHE 306 Design of Staged Separation Processes. Sem. 1. Class 3, cr. 3. Prerequisite: CHE 205, 211. The application of equilibria an mass and energy balances for the design of staged separation processes. Use of various equilibrium data and thermodynamic principles for the design of batch and continuous distillation, absorption, stripping, and extraction systems. Stagewise calculation s and graphical methods for design of binary systems. Design of multicomponents separators. Determination of stage efficiency and column size.

CHE 320 Statistical Modeling & Quality Enhancement. Sem. 2. Class 3, cr. 3. Prerequisite: CHE 205. Corequisite: MA 265. Statistical modeling methods, design of experiments, error analysis, curve fitting and regression, analysis of variance, confidence intervals, quality control and enhancement: emphasizes preparation for designing chemical engineering laboratory experiments and analyzing data.

CHE 461 Biomedical Engineering. Sem. 1. Class 1, cr. 1. An introduction to the field of biomedical engineering, with particular stress on the chemical engineer's role.

CHE 540 Transport Phenomena. Sem. 1. Class 3, cr. 3. Prerequisite: CHE 378. Continuation of CHE 377 and 378. Topics in fluid mechanics, heat transfer, and mass transfer, including unsteady state transport problems, stream function, potential flow, hydrodynamic and thermal layers, turbulence, and multi-component diffusion.

ECE 201 Linear Circuit Analysis I. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: ENGR 126. Corequisite: MA 261. Volt-ampere characteristics for circuit elements; independent and dependent sources; Kirchhoff's laws and circuit equations. Source transformations. Thevenin's and Norton's theorems; superposition. Thansient response of RC, RL, and RLC circuits. Sinusoidal steady-state and impedance. Instantaneous and average power.

ECE 207 Electronic Measurement Techniques. Sem. 1 and 2. SS. Lab. 1, cr. 1. Corequisite: ECE 201. Experimental exercises in the use of laboratory instruments. Voltage, current impedance, frequency, and wave form measurements. Frequency and transient response. Elements of circuit modeling and design.

FS 361 Food Plant Sanitation Sem. 1, Class 3, cr. 1. Prerequisite: one year of biology and one year of chemistry. Course meets during weeks 1-5. Relation of food plant sanitation to good manufacturing practices and regulations affecting sanitations; organization of a food plant sanitation program; sanitary building and equipment construction; selection of cleaning, sanitizing, and pesticidal compounds; water, air, and waste treatment; food storage and transportation.

FS 362 Food Microbiology. Sem. 1. Class 3, cr. 3. Prerequisite: BIOL 221. Microbiology of foods, with emphasis on the conditions for growth of microorganisms and degradation of food components, preservation methods and use of Hazard Analysis and Critical Control Point (HACCP), and microorganisms associated with foodborne illness.

FS 363 Food Microbiology Laboratory. Sem. 1. Lab. 2, cr. 2. Corequisite: FS 362. Methods for enumerating, isolating, and identifying micro-organisms important in food processing, preservation, and distribution.

FS 444 Statistical Process Control Sem. 2, Class 3, cr. 1. Prerequisite: STAT 225 or 301. Course meets during weeks 1-5 Basic concepts and techniques of solving quality problems and assuring the quality of production processes; emphasis is on quality improvement programs, problems-solving tools, control charts for variables and attributes, process capability analysis, and sampling methods.

FS 453 Food Chemistry. Sem. 1 and 2. Class 3, lab. 1, presentation 1. Prerequisite: Course work in Biochemistry, Course work in Organic Chemistry. Application of fundamental laws and concepts of chemistry, physics, and biology to the properties, composition, and storage of foods.

FS 467 Food Analysis. Sem. 2, Class 3, lab. 1, cr.4. Prerequisite: CHM 224, FS 453, STAT 301. Application of quantitative and qualitative physical, chemical, and instrumental methods of analysis to the examination of food products; evaluation of methods; data analysis; and interpretation of results.

FS 541 Postharvest Technology of Fruit and Vegetables. Sem. 2. Class 3, cr. 1. Prerequisite: 3 credit hours at lower division undergraduate level in Biochemistry. Course meets during weeks 11-15. Theoretical and applied aspects of methods being used for enhancing the quality and shelf life of harvested fruits and vegetables. Factors that affect the longevity of produce and technology used to control these factors and reduce deterioration of produce between harvest and consumption/processing will be emphasized.

FS 551 Magnetic Resonance for Food and Agriculture. Sem. 1. Class 3, cr. 3. Offered in even-numbered years. Introduction to the theory, methods, literature, and strategies of magnetic resonance applied to agricultural materials including foods, living organisms, and real processes. Illustrates uses of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopies as well as imaging (MRI) to nondestructively measure anatomy, composition, microstructure, and physical state and molecular state of specific components. Teaches spectroscopy and origins of functional properties.

F&N 315 Fundamentals of Nutrition Sem. 1 and 2. Class 2, cr. 3. Prerequisite: course work in Physiology, General, 6 credit hours in Chemistry, General. Credit not given for both F&N 303 and 315. Basic principles of nutrition and their application in meeting nutritional needs during the life cycle.

F&N 534 Human Sensory Systems and Food Evaluation Sem. 2. Class 2, lab. 1, cr. 3. Prerequisite: STAT 301. Overview of human chemosensory (taste, smell, chemesthetic) mechanisms and abilities; proce dural and statistical methods for evaluating the sensory responsiveness of people and the sensory properties of foods.

IE 230 Probability and Statistics in Engineering I. Sem. 1 and 2. Class 3, cr.3. Corequisite: MA 261. An introduction to probability and statistics. Probability and probability distributions. Mathematical expectation. Functions of random variables. Estimation. Applications oriented to engineering problems.

IE 330 Probability and Statistics in Engineering II. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: ENGR 126, IE 230. Continuation of IE 230. Introduction to statistical inference and experimental design. Correlation, regression, single and multi-factor ANOVA, non-parametric methods. Applications to statistical quality control.

IE 343 Engineering Economics. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: ENGR 12, MA 166. Cost measurement and control in engineering studies. Basic accounting concepts, income measurement, and valuation problems. Manufacturing cost control and standard cost systems. Capital investment, engineering alternatives, and equipment replacement studies. Not oprn to students with credit in CE 394.

IE 370 Manufacturing Processes I. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: CE 273. Principal manufacturing processes; metal cutting, grinding and metal forming operations, machine tools, tools and tooling. Nontraditional machining and welding. Introduction to computer-aided manufacturing and computer-aided graphics and design, N/C programming, robots, and flexible manufacturing systems. Classroom and laboratory demonstrations included. Not open to students with credit in ME 363.

IE 383 Integrated Production Systems I. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: IE 335. Basic concepts in the design and operational control of integrated production systems. Includes topics on facility layout and material handling, material flow and information flow, resource and capacity planning, and shop floor control and scheduling.

IE 577 Human Factors in Engineering. Sem. 1 and 2. Class 3, cr. 3. Survey of human factors in engineering with particular reference to human functions in human-machine systems, and consideration of human abilities and limitations in relation to design of equipment and work environments.

ME 270 Basic Mechanics I. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: Phys 172; Corequisite: MA 261. 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.

ME 300 Thermodynamics II. Sem. 1 and 2. Class 3, cr. 3. Prerequisite: ME 200, 263. Properties of gas mixtures, air-vapor mixtures, applications. Thermodynamics of combustion processes, equilibrium. Energy conversion, power, and refrigeration systems.

ME 418 Engineering of Environmental Systems and Equipment. Sem. 2. Class 3, cr. 3. Prerequisite: ME 300, 315. Design and analysis of systems and equipment used in conditioning buildings. Review of fundamentals in thermodynamics, heat transfer, fluid mechanics, economics, non-linear equation solving, optimization. Analysis of building heating and cooling requirements for design and annual energy use. Design and selection of equipment.

MSE 230 Structure and Properties of Materials. Sem. 1 and 2. Class 2, rec. 1, cr. 3. Prerequisite: CHM 115, MA 165. The relationship between the structure of materials and the resulting mechanical, thermal, electrical, and optical properties. Atomic structure, bonding, atomic arrangement; crystal symmetry, crystal structure, habit, lattices, defects, and the use of X-ray diffraction. Phase equilibria and microstructural development. Applications to design.

NUCL 273 Mechanics of Materials. Sem. 1 and 2. SS. Class 3, cr. 3. Prerequisite: ME 270. Analysis of stress and strain; equations of equilibrium and compatibility; stress-strain laws; extension, torsion, and bending of bars; membrane theory of pressure vessels; elastic stability, elected topics.

Biological and Food Process Engineering Student Record (Students entering Fall 2006)

Name _____ Student ID No. _____

Math & Sciences (40 cr)	Sem/Yr	Grade
CHM 115 (4)		
CHM 116 (4)		
CHM 257 (4)		
ENGR 126 (3)		
MA 165 (4)		
MA 166 (4)		
MA 261 (4)		
MA 265 (3)		
MA 266 (3)		
PHYS 172 (4)		
PHYS 241 (3)		

Communications (7 cr)		
COM 114 (3)		
ENGL 106 (4)		

Biological Sciences (8 cr)		
BIOL 221 (4)		
BIOL 230 (3)		
BIOL 295F (1)		

Biological Food Science (9 cr)		
F&N 205 (3)/BCHM 221 (3)		
Elec (3)		
Elec (3)		

Engineering (min 48 cr)	Sem/Yr	Grade
ABE 201 (3)		
ABE 202 (3)		
ABE 301 (3)		
ABE 303 (3)		
ABE 370 (3)		
ABE 454 (4)		
ABE 460 (3)		
ABE 555 (4)		
ABE 556 (4)		
ABE 580 (3)		
CHE 377 (3)		
CHE 378 (3)		
Elec (3)		
Elec (3)		
Elec (3)		

General Education Electives (18 cr) *[3 cr @ 300+]*		
Social Science (6 cr min)		
Econ Elec (3) –		
(3)		
Humanities (6 cr min)		
(3)		
(3)		
SS/Hum		
Written/Oral Com (3) –		
(3)		

Other (3 cr)		
AGR 101 / ENGR 100 (1)		
ABE 290 (1)		
ABE 490 (1)		

Total credits required for graduation = 133

Math/Sci	(40)	_____
Com	(7)	_____
Biol Sci	(8)	_____
Bio FS	(9)	_____
Engr	(48)	_____
Hum/SS	(18)	_____
Other	(3)	_____
Total credits earned		_____

International Understanding (6 cr) _____ _____

Multicultural Awareness (3 cr) _____

Final Audit Completed	Signature	Date
Student Svcs Coord	_____	_____
Advisor	_____	_____

Biological and Food Process Engineering Student Record - Biochemistry Dual

Name _____ Student ID No. _____

Math & Sciences (48 cr)	Sem/Yr	Grade
CHM 115 (4)		
CHM 116 (4)		
CHM 261 (3)		
CHM 262 (3)		
CHM 263 (1)		
CHM 264 (1)		
CHM 372 (4)		
ENGR 126 (3)		
MA 165 (4)		
MA 166 (4)		
MA 261 (4)		
MA 265 (3)		
MA 266 (3)		
PHYS 172 (4)		
PHYS 241 (3)		

Engineering (min 48 cr)	Sem/Yr	Grade
ABE 201 (3)		
ABE 202 (3)		
ABE 301 (3)		
ABE 303 (3)		
ABE 370 (3)		
ABE 454 (4)		
ABE 460 (3)		
ABE 555 (4)		
ABE 556 (4)		
ABE 580 (3)		
CHE 320 (3)		
CHE 377 (3)		
CHE 378 (3)		
Elec (3)		
Elec (3)		

Biological Sciences (18 cr)		
BIOL 121 (2)		
BIOL 131 (2)		
BIOL 230 (3) or 231 (3)		
BIOL 295F (1) or 232 (1)		
BIOL 438 (3) or BIOL 221 (4)		
BIOL Elective (3)		
AGRY 320 (3)		
AGRY 321 (1)		

Biochemistry (17 cr)		
BCHM 221 (3)		
BCHM 322 (2)		
BCHM 490 (1)		
BCHM 561 (3)		
BCHM 562 (3)		
BCHM 565 (2)		
BCHM 572 (3)		

Communications (7cr)		
COM 114 (3)		
ENGL 106 (4)		

Humanities/Social Science Electives (27 cr)		
ECON 251/252 (3)		

Other (3 cr)		
AGR 101 / ENGR 100 (1)		
ABE 290 (1)		
ABE 490 (1)		

Total credits required for graduation = 168

Math/Sci	(48)	_____
Biol Sci	(18)	_____
Biochem	(17)	_____
Date		
Engr	(48)	_____
Com	(7)	_____
Hum/SS	(27)	_____
Other	(3)	_____

Total credits earned _____

Add'l Com _____

Int'l Under _____ _____

Final Audit Completed Signature/Date

Advisor _____

Student Svcs Coord. _____

Multicultural Awareness _____

Biological and Food Process Engineering Student Record - Pharmaceutical Science

Name _____ Student ID No. _____

Math & Sciences (39 cr)	Sem/Yr	Grade
CHM 115 (4)		
CHM 116 (4)		
CHM 321 (4)		
ENGR 126 (3)		
MA 165 (4)		
MA 166 (4)		
MA 261 (4)		
MA 262 (4)		
PHYS 172 (4)		
PHYS 241 (3)		

Communications (7 cr)		
COM 114 (3)		
ENGL 106 (4)		

Biological Sciences (18 cr)		
BIOL 110 (4)		
BIOL 111 (4)		
BIOL 221 (4)		
BIOL 301 (3)		
BIOL 302 (3)		

Humanities/Social Science Electives (18 cr)		
ECON 251/252 (3)		

International Understanding _____ _____

Multicultural Awareness _____

Engineering (min 48 cr)	Sem/Yr	Grade
ABE 201 (3)		
ABE 202 (3)		
ABE 301 (3)		
ABE 303 (3)		
ABE 370 (3)		
ABE 454 (4)		
ABE 460 (3)		
ABE 555 (4)		
ABE 556 (4)		
ABE 580 (3)		
CHE 377 (3)		
CHE 378 (3)		
CHE 320 (3)		
Elec (3)		
Elec (3)		
Elec (3)		

Pharmaceutical Science (43 cr)		
IPPH 362 (3)		
IPPH 363 (3)		
IPPH 475 (3)		
IPPH 562 (3)		
MCMP 204 (4)		
MCMP 205 (4)		
MCMP 304 (3)		
MCMP 305 (3)		
MCMP 407 (3)		
MCMP 408 (2)		
MCMP 422 (3)		
MCMP 440 (3)		
MCMP 441 (3)		
MCMP 442 (3)		

Other (3 cr)		
AGR 101 / ENGR 100 (1) / IPPH 100 (1)		
ABE 290 (1)		
ABE 490 (1)		

Total credits required for graduation = 178

Math/Sci	(38)	_____
Com	(7)	_____
Biol Sci	(18)	_____
Hum/SS	(18)	_____
Engr	(52)	_____
Phar Sci	(43)	_____
Other	(3)	_____
Total credits earned		_____

	Signature	Date
Advisor	_____	
Final Audit Completed		
Student Svcs Coord	_____	_____
Area Rep	_____	_____
APC Chair	_____	_____

General Education Courses

Engineering Policy requires:

1. At least 9 credit hours of courses with global/societal content must be taken.
2. At least 6 credit hours must be taken and no more than 12 credit hours may be taken in one department.
3. At least 6 credit hours of non-introductory courses must be taken.
4. If a foreign language is taken, at least 6 credit hours are required in the same language. Credit is not allowed for language courses in the student's native tongue(s), but literature, culture, drama and related courses are allowed.
5. Credit by examination or granted credit, conditioned solely at the discretion of the awarding department, can be used to satisfy any part of the requirement.
6. No course may be used more than once, even if the offering department allows it to be repeated for credit.

The following are College of Agriculture and Department of Agricultural and Biological Engineering requirements:

7. Of the 18 credit hours total:
   3 credits must be selected from the Economics area
   3 credits from ASL or Communications (+200) or English (+200)
   3 credits (minimum) of the 18 must be +300 level
   6 credits of International Understanding electives
   3 credits in Multicultural Awareness

***** Introductory courses
School of Agricultural International Understanding
Courses in **bold** type are Multicultural Awareness courses

Social Sciences

Subject Area	Course Number
AGEC	*250, 296, 340, 406, 410, 415, 423, 450
ANTH	*100, *105, *203, *204, *205, *250, **303**, 320, 335, 336, 341, 350, 368, **379**, 390, 392, 404, 414, 415, 420, 425, 435, 436, 460, 473, 478, 479
ASL	*101, 102, 201, 202, *280
AUS	*115, 309, 401, 419
AUSL	*227, 368, 381
CDFS	*201, 210, 211, *255, 301, 311, 312, 315, 325, 411, 424, 430, 432, 434
COM	*204, 210, *212, *224, 240, *250, *251, 253, *256, 303, 312, 314, 316, 318, 320, 324, 325, 329, 330, 351, 352, 368, 372, 374, **376**, **381**, 412, 414, 416, 424, 435, 491
ECON	*251, *252, 340, 352, 355, 361, 365, 368, 370, 375, 380, 385, 422, 456, 461, 466, 470, 471
POL	*101, *120, *130, *141, *190, 200, *221, ***222**, *223, *230, *231, *232, *235, *237, *290, 300, 301, 303, 304, 314, 320, 322, 323, **326**, 327, 338, 342, 344, 345, 347, 348, 350, 351, 352, 353, **360**, 364, 370, 371, 372, 373, 380, 410, 411, 412, 413, 415, 416, 417, 418, 419, 423, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 444, 445, 446, 447, 449, 452, 453, 454, 455, 456, 460, 461, 462, 463, 493
PSY	*120, *121, *200, 213, *220, *235, 236, **239**, 240, 241, 242, *250, *251, *285, 310, 311, 314, 333, 335, 336, 337, 338, 339, 350, 360, 361, 364, 365, 366, 367, **368**, 370, 372, 380, 388, 391, 392, 415, 420, 425, 426, 428, 440, 442, 443, 444, 450, 463, 464, 473, 475, 476, 484, 485, 493
SOC	*100, ***220**, **310**, 312, 316, 324, 328, 334, 338, 339, 340, 341, 342, 350, 367, 368, 374, 391, 402, 411, 416, 419, 420, 421, 425, 426, 429, **450**, 454, 474, 475, 493

HUMANITIES

Subject Area	Course Number
A&D	*105, 106, *125, 200, 205, 206, *207, 213, 214, *215, *216, *217, 221, *226, *227, 230, 235, *242, 245, 246, 250, *255, 259, 262, *265, *266, *270, *271, 275, 276, 307, 311, 312, 314, 316, 327, 330, 332, 333, 341, 342, 350, 351, 353, 357, 358, 359, 362, 363, 365, 366, 368, 369, 370, 371, 376, 380, 381, 382, 383, 384, 385, 390, 391, 395, 398, 400, 421, 442, 450, 451, 452, 454, 455, 458, 462, 468, 470, 475, 476, 485, 490, 492
ARAB	*101, 102, 201, 202, 301, 302
CHNS	*101, 102, 201, 202, 220, *230, *241, *280, *285, 301, 302, 305, 313, 341, 342, 490, 493
CLCS	*230, *237, 330, 331, 335, 336, 337, 385
DANC	*101, *102, *103, *130, 140, 201, 202, 203, 240, 241, *250, 301, 302
ENGL	*201, *227, *230, *231, *232, *233, *234, *235, *237, *238, *239, *240, *241, *250, ***257**, *258, *262, *264, *266, *267, *276, *279, 304, 305, 327, 331, 333, 335, 337, 350, 351, 352, 356, **358**, **360**, 361, 362, 364, 365, 366, 368, 372, 373, 374, 375, 376, 377, 379, 381, 382, 383, 386, 387, 396, 406, 407, 409, 411, 412, 413, 414, 441, 442, 444, 455, 460, 462, 463, 466, 468, 469, 470
FLL	*101, 102, 201, 202, *230, *233, *235, *239, *261, *331, *361, 368, 371, 490
FR	*101, 102, 103, 112, 201, 202, 211, 212, *230, *231, 241, 260, 280, 301, 302, 330, 341, 342, 361, 362, 380, 394, 396, 401, 402, 443, 480
GER	*101, 102, 103, 112, 201, 202, 211, 212, *230, *231, 241, 260, 280, 301, 302, 323, 330, 341, 342, 360, 385, 401, 402, 441, 442, 446, 480, 483
GREK	*101, 102, 201, 202, 344, 446, 490
HEBR	*101, 102, 201, 202
HIST	*102, *103, *104, *105, *151, *152, *228, *229, *240, *241, *243, *245, *271, *272, *290, *302, 303, 307, 312, 317, 318, 320, 322, 323, 324, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 337, 339, 340, 341, 342, 343, 344, 345, 350, 351, 352, 353, 355, 356, 357, 358, 359, 360, 361, 362, **365**, **366**, 368, 371, 372, 376, **377**, 381, 382, 383, 385, 386, 387, 391, **396**, **398**, 399, 402, 403, 404, 405, 406, 407, 408, 409, 412, 414, 415, 416, 417, 419, 420, 427, 438, 439, 440, 441, 443, 450, 460, 461, 463, 465, 467, 468, 469, 471, 472, 473, 475, 492, 493, 494, 497
IDIS	*220, *260, ***271**, ***280**, **330**, **370**, 371, 371F, 372, 373, **375**, **376**, 378, 380, 381, 420, 460, 473, 480, **481**, 482, 483, 490, 490B
ITAL	*101, 102, 105, 112, 201, 202, 211, 212, *231, 241, 260, 301, 302, *330, 335, 341, 342, 394
JPNS	*101, 102, 201, 202, *230, 241, *280, 301, 302, 341, 342, 361, 362, 368, 401, 402, 480, 490
LATN	*101, 102, 201, 202, 343, 344, 345, 346, 442, 443, 444, 445, 446, 490, 492
MUS	250, 361, 362, 363, 364, 371, 372, 373, 374, 375, 377, 378, 490
PHIL	*110, *111, *206, *219, *221, ***225**, *240, ***242**, *260, *270, *275, *280, *290, 293, 301, 302, 303, 304, 306, 319, **330**, 331, 402, 406, 411, 421, 425, 430, 431, 432, 435, 465, 490, 493
PTGS	*101, 102, 105, 112, 201, 202, 211, 212
RUSS	*101, 102, *111, 112, 201, 202, 211, 212, 223, *230, *231, *232, *233, *234, *236, *237, 241, *281, *289, 301, 302, 330, 341, 342, 361, 362, 401, 402, 480
SPAN	*101, 102, 103, *112, 201, 202, 211, 212, 230, *231, ***235**, 241, 260, 280, 301, 302, 330, 335, 341, 342, 361, 362, 401, 402, 480, 481, 482
THTR	*168, *201, *202, 213, 233, *260, 323, 333, 334, 336, 380, 413, 433, 434, 440, 480

To the Academic Advisor: Courses not appearing on this list may be approved as General Education Electives depending on your school's particular requirements. Questions about the acceptability of a course not on this list should be directed to your School representative on the Engineering Education Committee, or the Chair of your school's Undergraduate Committee.

To the Student: You may petition to take courses not appearing on this list as General Education Electives. Please contact your Academic Advisor for details. However, if you are in the First-Year Engineering Program or considering a CODO, you are advised to take only courses that appear on this list.

APPENDIX

Engineering Design Experience

Engineering design is integrated in the curriculum beginning at the freshman year and culminating with a senior capstone course. Each ABE course contains some design and builds up to senior open ended problems as students complete the required 48 credits of engineering topics. Other disciplines in engineering as well as social and agricultural aspects and international cultures are part of the educational background interwoven into the Agricultural and Biological Engineering curriculum.

The first course that includes design introducing Agricultural and Biological Engineering topics and discussing potential problem solutions is ABE 120. During the sophomore year two classes (ABE 201/205 and 202/210) build on freshman computer skills and incorporate safety, ethic and social skills requiring verbal and written communication skills.

Agricultural and Natural Resources Engineering

Senior projects are provided by local engineers or alumni working in industry. These engineers provide at least 10 hours of contact with the undergraduates (sophomores and seniors) and have chosen engineering projects that are real world. This process of incorporating design early helps with sophomore retention and provides them with enthusiasm about the design process.

Junior year courses build on design with ABE 330 and ABE 325 requiring several open ended mini-designs. The students now utilize strength of materials, engineering materials, thermodynamics, statistics, and Computer Aided Design (CAD) to produce drawings of small parts they individually designed. ASM 211 and ABE 320 courses taken in the freshman-junior years provide students with CAD and Solid Modeling experience.

Senior design courses 435 (Hydraulic Control Systems for Mobile Equipment), 450 (Finite Element Method in Design and Optimization), 460 (Sensors and Process Control) and 485 (Agricultural Engineering Design) are all unique to Purdue engineering undergraduates. Because of this other engineering discipline students do take these courses.

Senior courses are taught by professors with industrial design experience. Other electives and required engineering courses also contain design and they include fluid mechanics (CE 340 or ME 309), and electrical circuits (ECE 201). Many alumni have assisted, and continue to assist, in the evolution of the curriculum.

Biological and Food Process Engineering

The design experience in this program starts in the sophomore year, but is emphasized in the junior year. This provides an excellent opportunity to build on the engineering sciences, arranged mostly in semesters 3, 4, and 5. Economic constraints relative to engineering systems are brought into the program by recommending one of the General Education Electives be an economics course that is taken prior to the senior year.

The students are exposed to tackling open ended design problems in ABE 454 and 555. Our comprehensive engineering design course, ABE 556, Biological and Food Process Design is a 4-credit course. This extra period allows increased emphasis on the design process. Designing in an economic manner is the main focus of ABE 556.

Academic Minors Available to Agriculture, Agricultural and Biological Engineering, and Forestry Students

May 2007

Aerospace Studies	315
African American Studies	370
Agr Systems Management	120
Animal Sciences	148
Anthropology	371
Art and Design	349
Art History	351
Asian Studies	352
Astrophysics	762
Biological Sciences	710
Biotechnology	880
Chemistry	720
Child Dev & Family Studies	501
Chinese	334
Classical Studies	348
Communication	340
Computer Science	730
Creative Writing	354
Crop Science	130
Dance	355
Earth and Atm Science	740
Economics	602
Electrical & Computer Engr	050
English	373
Entomology	118
Envrmtl Politics and Policy	372
Family Business	502
Farm Management	115
Film/Video Studies	356
Food & Agribusiness Mgmt	116
Food Science	117
Foods and Nutrition	330
Forensic Science	088
French	374
German	375
Health Promotion	364
History	376
Horticulture	190
International Studies	78A
Italian	336
Japanese	353
Jewish Studies	399
Latin	333
Law and Society	337
Linguistics	339
Management	670
Mathematics	750
Mechanical Engineering	280
Medieval Studies	380
Military Sci & Leadership	314
Music History and Theory	350
Natl Res & Envrmtl Science	106
Naval Science	400
Nuclear Engineering	290
Nutrition	329
Occupational Health	092
Org Leadership & Supervision	807
Peace Studies	312
Philosophy	382
Physics	760
Plant Biology	127
Plant Pathology	128
Political Science	384
Portuguese	338
Psychology	379
Radiological Health	091
Religious Studies	387
Russian	388
Sociology	389
Soil Science	134
Spanish	390
Statistics	770
Theatre	391
Weed Science	129
Wildlife Science	119
Women's Studies	398
Wood Products Manufac Tech	176

Special Problems Courses

ASM 490 Special Problems, ASM 499H Honors Thesis, ASM 590 Special Problems
ABE 495 Select Topics in Agricultural and Biological Engineering
ABE 498 Undergraduate Research in Agricultural and Biological Engineering
ABE 499H Honors Thesis Research, ABE 590 Special Problems

Purpose of Special Problems Course Offerings
Special Problems course offerings should be designed to provide capable students the opportunity to work on carefully selected special problems which are not covered in regular course offerings. The problems should be closely related to the students' field of study and be of mutual interest to both the individual student and supervising faculty member.
The selected problem should be such that it will require the student to perform a combination of laboratory, field, and/or library studies and result in a professionally written report of the activities relating to the project, findings if any, and other related documentation.

Student Eligibility
Students requesting enrollment in Special Problems courses should have a record of exhibiting a great deal of personal initiative and the ability to work toward a solution of problems with limited direct supervision from instructors.

Registration for the Special Problem
Due to the extensive time required to plan and complete a Special Problem course, instructor selection and completion of the contract should take place in the semester *prior* to the one in which the course is to be completed. Registration for a Special Problems course after two weeks into the semester is not accepted.

Student/Faculty Contract for Special Problems
To provide documentation of the problem to be addressed and to ensure a clear understanding between the student and supervising faculty member of their respective expectations, a formal course contract must be completed and a kept on file by the faculty member. An additional copy will be placed in the student's permanent file, and a copy will be furnished to the student.

Approval of the Special Problems Courses by the Department
In order to ensure that proposed courses meet the expectations of the department with respect to content, level of effort and credit hour distribution, each Special Problems course must be approved by the Agricultural & Biological Engineering Academic Programs Committee (or, in the case of a graduate student, the Graduate Committee). Approval should be obtained by the end of the semester *prior* to the one during which the course will be completed or ***no later than the second week*** of the semester during which the course is to be completed.

Enrollment in ABE 495/590 or ASM 490/590 – In addition to the above, the student should fulfill the following requirements:

1. Be enrolled as an undergraduate or graduate student at Purdue.
2. Be classified as a "Junior 6" or higher at the time the course begins.
3. Have a minimum grade point average (GPA) of 3.00.

Exceptions to the above requirements will be considered by the ABE Academic Programs Committee/ Graduate Committee upon request of the instructor.

See Yvonne Hardebeck in Room 201 for sample

See Yvonne Hardebeck in Room 201 for sample

Admission to Graduate School

Undergraduate students looking forward to graduation frequently consider graduate work as a possibility after graduation. The advisor should encourage students to go to graduate school provided the student is qualified and able to benefit from graduate study.

The basic requirements for admission to graduate study are:

- Graduation with a baccalaureate degree.
- An applicant is generally expected to maintain a cumulative grade point average of at least 3.0.

Most students enrolled in graduate study in the Agricultural and Biological Engineering Department receives graduate research assistantships. Current stipends for M.S. and Ph.D. assistantships are approximately $14,000 and $16,500 per year, respectively, plus full waiver of tuition and most fees. Fellowships are available in some instances with stipends of up to $22,000 per year. Therefore, the true value of an assistantship is approximately $17,000 per year for Indiana residents and $24,000 for non-Indiana residents.

In certain cases undergraduate students may subsequently apply credits they have earned in 500-series courses toward an advanced degree at Purdue. Upon admission to the Graduate School, and with the approval of the major field, a maximum of 6 credits relevant to the graduate program of study which were not used to satisfy undergraduate requirements may be applied toward an advanced degree. The form for this request is available in the Student Academic Center, ABE room 201.

Research Opportunities. Modern, well-equipped laboratories support all research specializations; exceptional computing facilities being a noteworthy example. Departmental computing is centered on server-based, advanced engineering workstations. Departmental networks have integrated global capabilities as part of the Engineering Computer Network, a system of more than 1,000 workstations/ servers with supercomputer and Internet connectivity through the Purdue University Computing Center.

Bioprocess engineering is rapidly becoming a critical forefront research area as advances in genetic engineering lead to new types of crops and new methods for processing them into value added products. As a consequence, the department has a strong biological and biochemical technology research program. Research topics include bioreactor design and modeling, enzyme kinetics and biocatalysis, site-directed mutagenesis, foam fractionation and liquid chromatography of proteins, and genetic engineering. Extensive laboratory facilities include liquid chromatographs, glucose analyzers, fermenters, centrifuge, spectrophotometers, and preparative scale protein purification systems.

Areas of machinery research include electro hydraulic systems and their control, microprocessor applications for control and monitoring, the development of robotic systems for agricultural production/ processing, the development of design expert systems, finite element analysis and optimization of mechanical systems, design automation, soil-vehicle interactions, and operator safety. Facilities include engine dynamometers and hydraulics, as well as machine vision laboratories.

Research in water resources planning and management includes studies of the mechanics of soil erosion, water quality control, mathematical simulation of agricultural watershed hydrology, geographical information systems (GIS) applications, and land drainage. The USDA/ARS National Soil Erosion Laboratory, located near the Agricultural & Biological Engineering Building, offers both facility and personnel support through cooperative projects.

Knowledge engineering, the art and science of automating the utilization of intelligence to manage and control tomorrow's increasingly interdependent subsystems, is an area of rapid research growth. This field spans such diverse areas as developing pattern recognition technologies for machine vision to creation of expert systems for both strategic management decision support and advanced machine controls.

Designing advanced methods for producing and processing biological products requires knowledge of the physical properties of biological materials and of soils. Many challenging research opportunities may be found in studying the mechanical, electrical, optical, rheological or other properties of such materials and in the development of transducers for machine monitoring and control of product characteristics.

Areas of Study. The Department of Agricultural and Biological Engineering offers opportunity for creative endeavor in academic coursework and in fundamental and applied research. Both the Master of Science and Doctor of Philosophy programs are offered in a broad range of areas including: artificial intelligence applied to decision support systems and to intelligent machine control, biochemical and food process engineering, agricultural systems management, physical properties of biological materials, computer-aided agricultural machinery design, soil and water resource design and management, crop processing and storage, systems engineering, fluid power, agricultural structures, renewable resource utilization, vehicle mechanics, and environmental control.

Requirements for Graduate Study. Applications for graduate study in agricultural and biological engineering are accepted from qualified individuals who have a baccalaureate degree in engineering or agricultural systems management from a college or university of recognized standing. These students may work toward Master of Science in Agricultural and Biological Engineering (M.S.A.B.E.), Master of Science in Engineering (M.S.E.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) degrees.

The doctoral degree candidate must have demonstrated superior scholastic and research ability either at Purdue or some other university. Research ability normally is assumed if the applicant has written an acceptable master's thesis. Students who complete a nonthesis M.S. degree program normally will not be permitted to pursue a Ph.D. program.

Programs of Study. The master's degree candidate may elect either a thesis or nonthesis option program. A thesis is required for the Ph.D. degree. Research assistantships generally are not available to individuals electing the nonthesis option.

A minimum of 24 semester hours for the master's degree with a thesis, 30 semester hours for the master's degree without a thesis, and 48 semester hours for the doctoral degree normally are required. Acceptable master's degree coursework may be applied to the doctoral degree program. Outstanding students may petition to work directly toward the Ph.D. without the M.S. A minimum of six semester hours of departmental courses is required in the master's degree program with a thesis and 12 semester hours for the nonthesis master's degree and doctoral degree programs.

Mathematical sciences must be pursued in depth. Normally, for the master's degree a minimum of six credit hours of mathematical, statistical, or computer science courses beyond ordinary differential equations is required. For the doctoral degree, a minimum of 12 credit hours is required.

Programs of study must be established during the first full semester for the master's, or full year for the doctoral degree, of residency at Purdue University. These programs are oriented toward the proposed thesis research work in one of the research areas in agricultural engineering.

There are no foreign language requirements for the M.S. and Ph.D. degrees.

Specific inquiries concerning the opportunities for graduate study in ABE should be addressed to the ABE Graduate Secretary (ABE room 201).

ABE Faculty

Faculty	Office	Campus Phone (49-___)	Email (_@purdue.edu)	Area of Specialization
Vincent F. Bralts (Assoc. Dean of Engineering)	ENAD 111	45349	bralts	*Irrigation design and management*; Hydraulic network analysis using Finite Element Method; Water quality modeling; International development.
Dennis Buckmaster	ABE 217	69512	dbuckmas	
Osvaldo Campanella	FS 2151	66330	campa	*Food process engineering.* Food Rheology. Food Extrusion, evaporation. Food processes simulation.
Natalie J. Carroll	AGAD 216	48433	carroll	*Soil and water engineering*; Finite Element Models; Youth environmental programs.
Indrajeet Chaubey	ABE 216	45013	ichaubey	Ecohydrology, solute and sediment transport, best management practices to minimize nonpoint source pollution, spatial variability of natural processes, land use terrestrial and aquatic processes, integrated watershed/water quality management technology, mathematical modeling, and application of geographic information systems and remote sensing
Keith A. Cherkauer	ABE 312	67982	cherkaue	Remote sensing, hydrology models, environmental change, land-atmosphere interactions, the hydrologic cycle, the impact of snow and soil frost on the surface water, energy balance in the upper Mississippi River basin, applicability of aircraft- and satellite-based thermal remote sensing to monitoring stream temperatures.
Heidi Diefes-Dux	ENAD 206	43887	hdiefes	Educational methods research as it pertains to the development of engineering courses and curricula. Food process engr - unit operations, process, and plant modeling and optimization through experimentation and theory.
Bernard A. Engel (Dept. Head)	ABE 218	41162	engelb	Artificial intelligence; Expert systems; Simulation; Soil and water engineering; Natural resource conservation and management; Geographical information systems.
Daniel R. Ess	ABE 311	63977	ess	Development and analysis of information intensive agricultural production systems.
William E. Field	ABE 308B	41191	field	Agricultural safety and health; Breaking New Ground Resource Center.
Dennis C. Flanagan (Adjunct)	SOIL 107	47748	flanagan	Soil and water resources; Erosion mechanics, prediction, and control; Sediment deposition; Water quality
Jane Frankenberger	ABE 208A	41194	frankenb	Water quality; Watershed protection; Soil and water engineering; Geographical information systems; Hydrologic simulation modeling
Kamyar Haghighi (Head, Engineering Education)	ENAD 203	43884	haghighi	Finite element modeling and analysis; Computational techniques; Design and automation; Knowledge-aided mechanical design; Machine systems Engineering.
Albert J. Heber	ABE 215	41214	heber	Building ventilation; Indoor air quality; Air pollution; Wood coatings.
Klein E. Ileleji	ABE 309	41198	ileleji	Grain quality , post-harvest engineering, sensors and Process Controls, biomass production and handling, production of energy crops, new technology development, biomass characterization, and production, densification and post-harvest technologies for biomass utilization.
Joseph Irudayaraj	NA	41162	josephi	Sensor device fabrication and study of individual molecules using confocal spectroscopy and microscopy to better understand their mobility and interaction. Applications include health and food.
Monika Ivantysynova	ABE 314	66578	mivantys	Modeling of pumps, motors, actuators, and complex fluid power systems, advanced CVT transmission concepts, energy saving actuator technology
Don D. Jones	ABE 208B	41178	jonesd	Structures and environment; Home and agricultural waste management.
Gary W. Krutz	ABE 213	41179	krutz	Power and machinery; Fluid power electronic control for machinery applications; Agricultural sensor development.
Michael R. Ladisch	POTR 216	47022	ladisch	Biotechnology and bioprocess engineering; Bioseparations; Chemical reactor design and kinetics; Biomass conversion.
Chang Lu	ABE 217	41188	changlu	Microfluidics and Nanobiotechnology. Microfabricated biosensors for food safety. Drug delivery using microfluidic devices. Single molecule biophysics using fluorescence spectroscopy.
John Lumkes	ABE 216	41173	lumkes	Electrohydraulics; on- and off-road vehicle design; drive-by-wire control systems; and diagnostics and prognostics for hydraulic and pneumatic systems
Dirk E. Maier	ABE 210	41175	maier	Post-harvest engineering of agricultural crops; Alternative crop storage technologies; Value-added processing; Crop dehydration; Food processing
Gaines E. Miles	ABE 313	41223	gem	Intelligent machine design; Robotics; Sensors; Precision agricultural management systems.
Rabi H. Mohtar	ABE 321	41791	mohtar	Environmental resources engineering; Numerical methods; Simulation models to improve utilization of natural resources; Hydrological systems interaction with the environment; Irrigation systems.
Mark T. Morgan	FS 1161	41180	mmorgan	Electronic sensing of food properties; Design of food processing control systems.
Nathan S. Mosier	ABE 211	62044	mosiern	***Bioprocessing R***renewable resources to fuels, chemicals, & pharmaceuticals. ***Biocatalysis.***

Ganesan Narsimhan	FS 2247	41199	narsimha	Food engineering; Bioseparations; Food emulsions and foams; Functional properties of proteins.
Martin R. Okos	FS 1171	41211	okos	Food process engineering; Computer aided design of food processes; Heat and mass transfer in foods; Fermentation and biological reactor design; Properties of food; Biological products.
Marshall Porterfield	ABE 319	41195	porterf	Biological engineering, sensor technology and instrumentation, BioMEMS, eukaryotic cell signaling, space and gravitational biology
Jenna L. Rickus	ABE 214	41197	rickus	Biosensors; Bio-nanotechnology; Mathematical Modeling.
Richard L. Stroshine	ABE 308	41192	strosh	Physical properties of agricultural materials; Sensing food quality; Grain quality; Grain drying; Handling storage; Grain Harvesting.
Bernard Y. Tao	FS 3239	41183	tao	Biocatalysis; Biomaterials utilization; Recombinant genetic engineering; Carbohydrate enzyme technology.