A Joint Program of

Department of Chemical, Biological and Bioengineering
College of Engineering
&
Department of Natural Resources and Environmental Design
College of Agriculture and Environmental Sciences

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INTRODUCTION

Biological Engineering (BIOE) is a branch of the engineering profession that integrates sciences, mathematics, and engineering with living systems. As such, BIOE incorporates traditional engineering disciplines such as mechanical, electrical, civil, computer, industrial and chemical along with mathematics, chemistry, biology and other sciences to deal with biological systems. “BIOE brings engineering to life” or “BIOE brings life to engineering.” A Biological Engineer learns the design and engineering principles taught in these fields and uses them to solve problems related to food, energy and water insecurities and the environment.

Our global society is facing a major problem due to the depletion of natural resources caused by food and energy production and urban related activities. Finding a solution to problems such as energy, food and water shortages; biological diversity and ecosystem losses; soil, water and air pollution; climate change; and waste management, will require the ingenuity of Biological Engineers. These engineers serve society by designing biological systems that use and conserve natural resources.

In summary, Biological Engineers are analysts, designers, and managers who solve complex problems by combining biological, physical, chemical, computer and engineering sciences. The success of these engineers depends on their training and the ability to work on multidisciplinary teams.

HISTORICAL BACKGROUND

Since 1945, Biological Engineering has been offered at North Carolina A&T State University (NCA&T). The ‘engineering’ aspect of BIOE began with Mr. L.A. Yates when he added structures and mechanics to the program. In 1982, Dr. Godfrey A. Gayle received his Ph.D. in Biological and Agricultural Engineering from North Carolina State University. He became the first African American graduate of NC State University to earn a Ph.D. in that field and the second black person in the USA with the terminal degree in the field. He however has worked at NCA&T since 1979 after receiving the MS degree in Biological and Agricultural Engineering. The faculty was further strengthened by the recruitment of Drs. A. Shahbazi in 1983 and Mr. Phillips, a Professional Engineer in 1988. The trio, under the leadership of Dr. Gayle, engineered the national accreditation of the B.S. biological engineering degree (at that

Current staff members include: Ms. Michele Mims (Laboratory Manager), Mr. Matthew Todd (Research Engineer) and Mr. Kevin Brown (Computer Network Manager). BIOE has several postdoctoral research associates: Dr. Shuangning Xiu, and Dr. Bo Zhang.

The undergraduate program in Biological Engineering, leading to the Bachelor of Science in Biological Engineering (BSBE) degree, is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC-ABET).

The program has two concentrations:

1. Bioprocess Engineering with an emphasis on the transformation of biological materials into products such as biodegradable polymers, hydrogen fuel, ethanol and biodiesel fuels,
2. Natural Resources Engineering focusing on designing biological systems that utilizes and conserves natural resources such as water, soil, air, and biodiversity.

ADMINISTRATION

Biological Engineering is offered jointly by the College of Agriculture and Environmental Sciences and the College of Engineering. The program is directed by Dr. Abolghasem Shahbazi. BIOE follows the same guidelines as other programs in the College of Engineering.

MISSION STATEMENT, EDUCATIONAL OBJECTIVES AND STUDENT OUTCOMES

The mission of the BIOE program is to provide its students with a quality biological engineering education and to satisfy the educational and technical needs of society on local, national and international levels.

To fulfill its mission, the Biological Engineering program has the following educational objectives:

1. Demonstrate the ability to work productively and ethically as Biological Engineers or to pursue graduate education.
2. Have the skills to actively lead or participate in multi-disciplinary teams.
3. Be active in professional societies, engage in continuing education, and progress towards professional registration.
4. Contribute to society and to the diversity of the workforce in their company and in their profession by actively recruiting and serving as mentors for these organizations.

After completing the biological engineering program, the students will attain these student outcomes:

a. Ability to apply knowledge of mathematics, science and engineering in problem solving
b. Ability to design and conduct experiments, and analyze and interpret data
c. Ability to design a system, component, or process with required constraints
d. Ability to function on multidisciplinary teams
e. Ability to identify, formulate and solve engineering problems
f. Ability to understand professional and ethical responsibility
g. Ability to communicate effectively
h. Ability to understand social and global aspects of engineering solutions
i. Ability to engage in life-long learning
j. Demonstrate knowledge of contemporary issues
k. Ability to use modern engineering tools and techniques
l. Ability to demonstrate knowledge of biological systems

SCHOLARSHIPS

Scholarship funds available to BIOE majors are awarded on the basis of academic performance and financial need. To obtain a scholarship, students must generally maintain an overall GPA of 3.75. Scholarships can be withdrawn if a minimum GPA of 3.0 is not maintained over two consecutive semesters.

Scholarships are currently offered to the students through funds made available by the following organizations and individuals:

- USDA-Natural Resource Conservation Service (NRCS)
- E.S. Carr
- Lee A. Yates
- Bernard A. Marshall
- School of Agriculture
- College of Engineering
- Maurice Smith
A number of other scholarships, such as the USDA-Natuculture Scholarship, are available on a competitive basis to qualified students. Announcements of scholarships, internships, and other employment opportunities are regularly e-mailed to students and posted on the Information Board in Sockwell Hall and McNair Hall.

PROGRAM OVERVIEW

A. WHO CAN BE A BIOLOGICAL ENGINEER?
Anyone who is interested in applying engineering to serve society through safe production of food and energy, while protecting the environment and conserving natural resources.

B. SALARY EXPECTATIONS
Average starting salary of a Biological Engineer is $64,610.

C. CAREER OPPORTUNITIES
Examples of agencies and companies BIOE alumni were employed are in parenthesis.

- Industries (Duke Energy, General Mills, John Deere, BASF, Mars Inc, & Syngenta)
- Government Agencies (USDA ARS, NRCS, & FS; EPA, DOE, Corp & State & Local)
- Research and Development (USDA-ARS, John Deere and several universities)
- Teaching and Communications (Several universities, community colleges and K-12)
- Private Consulting (Anderson, Accenture, Louis Berger, and Schnabel Engineering)
- Foreign/International Employment (Peace Corp, USDA-Forest Service)
- Urban Engineering (Cities of Greensboro, Cary, Miami & Washington DC)
- Water Management (USDA-NRCS, Schnabel Engineering, Forest Service)
- Soil and Water Quality Modeling (South Florida Water Management District, EPA)
- Wetlands (Habitat Assessment and Restoration Program, Inc.)

D. GENERAL COURSES TO BE TAKEN
- Chemistry
- Physics
- Engineering Sciences and Engineering Design
- Biological and Environmental Sciences
- Humanities/Social Sciences
- English
E. **SPECIFIC COURSES TO BE TAKEN**

- Engineering Properties of Biological Materials
- Surveying and Land Utilization
- Irrigation and Drainage Engineering
- Water Resources Engineering (Development, Supply and Distribution)
- Hydrology
- Renewable Energy Systems
- Solid and Hazardous Waste Management
- GIS (Geographic Information Systems)
- Systems Analysis and Design
- Bioprocess Engineering
- Urban Ecological Engineering
- Instrumentation of Biological Systems

**ACADEMIC REQUIREMENTS**

It is recommended that incoming freshmen have a SAT score of at least 1,230 (with a Math ≥ 570 or higher) ACT 26 and a high school GPA of 3.75. Transfer students should have a GPA of at least 3.0 on a 4.0 scale, unless transferring from an ABET accredited program, in which case, a GPA of at least 3.0 is required. All BIOE majors must complete the curriculum requirements for the year they enter this program (Appendix C). BIOE Electives must be selected from upper level Engineering Classes.

Changes from the prescribed curriculum must be made by consulting with an academic advisor and the Program Director. To be in good standing in the BIOE program, students must maintain at least a B average, that is, a 3.0 GPA on a 4.0 scale. This policy applies to all engineering programs in the College of Engineering (COE). In addition, COE has a list of courses wherein students are required to get a ‘C’ or above grade to meet graduation requirements. Furthermore, a minimum grade of “C” on any such course will be required to satisfy prerequisites of subsequent courses. For Biological Engineering the courses with this “Minimum C” requirement are:
Moreover, listed below are Biological Engineering major courses that require a grade of “C” or above:

<table>
<thead>
<tr>
<th>BIOE 330</th>
<th>BIOE 502</th>
<th>BIOE 423</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 495</td>
<td>BIOE 496</td>
<td>BIOE 415</td>
</tr>
<tr>
<td>BIOE 400</td>
<td></td>
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</tbody>
</table>

All BIOE majors, before advancing to the sophomore level, must achieve a grade of “C” or better in ENGL 100 and MATH 131. Students not meeting the above requirements will be counseled by the advisor and Program Director to select another major or continue as a BIOE major with a reduced course load for further observation. Courses, in which grades below “C” were earned during the freshman year, will be repeated while the student takes a lighter load the next semester.

COE policy states that a student can only take CHEM 106, MATH 131, and PHYS 241, twice. After two attempts if a student cannot get a grade of ‘C’ or better in these three courses, the student will be dismissed from the College of Engineering. Courses taken in the regular semesters and in the summer count as attempted courses even if they have been withdrawn.
ADVISING AND REGISTRATION

A. ADVISING

A student majoring in Biological Engineering or working toward becoming a BIOE major is assigned a faculty advisor by the Program Director. The advisor: (1) provides information, advice, mentoring and makes recommendations in academic and related areas, (2) stresses academic regulations, explains course prerequisites and graduation requirements, (3) helps new student to understand the degree to which s/he should assume responsibility for her/his own program planning (expectations), (4) provides vocational guidance and occupational information in her/his area of specialty, (5) refers the student to the appropriate individual, office, or agency when further assistance is needed, (6) monitors the student’s progress, (7) assists in placing students in co-ops or summer internships, and (8) assists students with finding employment or continuing studies at the graduate level.

The Department has a policy of strong academic advising. The effectiveness of the policy rests with the student becoming knowledgeable about the program and the involvement and dedication of her/his faculty advisor. Good student advising starts at the freshman level and is critical. The advisor remains in close contact with new students throughout their first year. The Department uses experienced senior faculty to advice freshmen students.

B. TRANSFER POLICY

The advisors in consultation with the Program Director assist all transfer students during their first year at NCA&T to assure consistency in transfer credit evaluation. In concert with the Office of Admissions, the content of the courses taken elsewhere are carefully examined to make sure that they are equivalent to courses offered at the University before they are transferred. When all entrance requirements and transfer credits are evaluated, the student is assigned a permanent advisor by the Program Director.

Each student must obtain the advisor’s approval for all course enrollment transactions including pre-registration, registration, and course changes. It is the student’s responsibility to ensure that s/he has passed the prerequisites before enrolling in the next course and that courses identified as co-requisites are taken as specified. A curriculum check sheet is utilized by the faculty advisor to ensure that each student follows the curriculum. After the end of each semester, faculty advisors receive student grades. At that point, they check for
any failed or dropped courses which may have an impact on the student’s schedule for the next semester. If a problem is detected, the advisor meets with the student at the beginning of the next semester (during the registration period) and makes the necessary changes to the schedule. The advisor will encourage the student to attend tutorial sessions, if necessary.

C. REGISTRATION PROCEDURES

Registration, pre-registration, and drop/add can be handled within the Department in the time allowed. Early registration advisement each semester allows the student and her/his advisor to review the student’s record and plan a program for the next semester or academic year. At this time, the student has an opportunity to discuss academic problems with the advisor if such problems were not detected and discussed earlier.

Early online registration follows early registration advisement and helps to ensure that the courses requested on the schedule will be available to the students the following semester. Students who are enrolled in the University are expected to register during early registration. Students who register after early registration may be subject to a late registration penalty ($50), and they face a lack of course availability due to course sections being full and closed.

Students who register early must pay their bill by the specified deadline or the courses will be dropped. The payment of fees is part of the registration process. No student is eligible to attend classes until the required fees have been paid.

In order for a student to receive credit for a course, s/he must be properly registered in that course. It is the student’s responsibility to ensure that s/he is attending the appropriate course section. The instructor will have a roster with the names of students who are enrolled in that section. Each student should make sure that her/his name appears on the class roster. Additionally, courses can only be repeated twice.

D. DROP/ADD PROCEDURES

Students may change their schedule by dropping or adding courses within the time allowed either online or within the Department. Online drop/add usually takes place during the first week of the semester. A change in the student’s program may be made with the consent of advisor or the Program Director. Course substitution is not usually encouraged. However, when necessary, course substitutions are approved by the Program Director. The signatures of the Chairperson and Dean are required for course substitutions.
E. **AUDITS**

Students who take courses as audit credit must officially register for the course. Attendance, preparation, and participation in classroom discussions and laboratory exercises shall be at the discretion of the instructor. Auditors are not required to take examinations and tests, and they receive no credit. Audited courses do not satisfy prerequisites. Audit credits cannot be changed for required credits.

F. **COURSE LOAD**

The average course load in Biological Engineering is 15 credit hours per semester. Students must carry a minimum of twelve credit hours per semester in order to be classified as a full-time student. The maximum course load that a student may carry is 18 hours; however, if s/he has a cumulative grade point average of 3.75 or higher, s/he may be permitted to take additional credit hours with the Dean’s approval. The maximum course load that a student on academic probation may carry is 12 semester hours.

**UNIVERSITY CLASS ATTENDANCE POLICY**

The University does not have a compulsory class attendance policy. However, regular and punctual class attendance is the responsibility of the individual student. Moreover, the student is expected to have sufficient maturity to assume the responsibility for regular attendance and to accept the consequences of failure to attend. The non-compulsory class attendance policy places responsibility on the student. Some instructors have compulsory attendance policies indicated in syllabi.

A. **STUDENT’S RESPONSIBILITY**

- The student is responsible for all material covered in each course for which s/he is registered. Absence from class does not relieve her/him of this responsibility.
- The student is expected to be present for laboratory periods, scheduled examinations, and other activities that may require special preparation.
- The student is responsible for initiating any request to make up an examination, a laboratory exercise, or other work missed because of absence. If the instructor requests a statement concerning the reason for the absence, the student must have a valid excuse which can be obtained from a physician, the Vice Chancellor for Student Affairs etc.
• Student is expected to report to class at the beginning of the term with a validated registration schedule.

• Students are responsible for making sure that their names appear on the instructor’s official class roster, and alternatively; a student should make sure that s/he has been officially dropped from the courses from which s/he requested to be dropped. Such students should keep a copy of the revised course schedule.

• The student is expected to follow the checklist given her/him as s/he is matriculated through the curriculum.

B. INSTRUCTOR’S RESPONSIBILITY

• The instructor is responsible for explaining to the class any specific expectations concerning attendance at the beginning of the term.

• The instructor should make sure that only students officially enrolled are attending class.

• The instructor is responsible for providing the student with a syllabus and a schedule that will provide a basis for evaluating student performance.

• The instructor is responsible for maintaining a record of the attendance of the students in her/his classes (class roster). The instructor is expected to inform the student when her/his academic progress is adversely affected by excessive absences or failures.

• The instructor will present lectures in a clear manner to be understood by the student.

• The instructor is expected to encourage student participation.

• The instructor is expected to be punctual and prepared.

STUDENT ORGANIZATIONS

A. THE AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS (ASABE)

The North Carolina Agricultural and Technical State University Chapter of ASABE endeavors to promote the professional development of its student members through its commitment to serve the community and participation in agricultural and engineering related activities. We were the first Minority Institution or Historically Black College or University in the USA to have a nationally accredited Biological Engineering degree. Currently, there are two. The University ASABE Chapter also runs contemporaneously with Alpha Epsilon, the honor society for Agricultural and Biological Systems Engineering. Comprising more
than 9,000 members in over 100 countries, ASABE is an educational and scientific organization dedicated to the advancement of engineering applicable to agricultural, food and biological systems.

ASABE NCA&T Chapter Advisor: Godfrey Gayle and/or Niroj Aryal
gayle@ncat.edu naryal@ncat.edu

President NCA&T Chapter: Ms. Dara Bradley
dmbradle@aggies.ncat.edu

B. ALPHA EPSILON

Alpha Epsilon is the honor society for engineering in agricultural, food and biological systems. It strives to promote excellence within the profession by recognizing and bringing together those who have demonstrated excellence through academic achievements and/or distinguished professional practice.

DEPARTMENT OF NATURAL RESOURCES and ENVIRONMENTAL DESIGN

Alpha Epsilon: Honor Society of Agricultural and Biological Engineering

The purpose of this organization is to promote the high ideals of the engineering profession to give recognition to those agricultural and biological engineers, who manifest worthy qualities of character, scholarship and profession attainment, and to encourage and support such improvement in the agriculture and biological engineering profession that make it an instrument of greater service to mankind.

Dr. Godfrey Gayle, (336) 285-3831, gayle@ncat.edu
Dr. Abolghasem Shahbazi, (336) 285-3830, ash@ncat.edu

The American Society of Agricultural and Biological Engineers (ASABE)

The American Society of Agricultural and Biological Engineers (ASABE) is an educational and scientific organization dedicated to the advancement of engineering applicable to agricultural, food, and biological systems. Founded in 1907 and headquartered in St Joseph, Michigan, ASAE comprises 9,000 members in more than 100 countries.

Dr. Godfrey Gayle, (336) 285-3831, gayle@ncat.edu
UNIVERSITY ACADEMIC REGULATIONS

A. REPETITION OF COURSES

A student who has received a failing grade in a required course at this University must repeat and pass the course unless the Dean of the College/School authorizes a substitute course. No single course may be repeated more than (2) two times. A student can only repeat a maximum of five courses. Courses taken in the regular semesters and in the summer count as repeated courses even if they have been withdrawn. In order to officially repeat a course, the student must fill out the Course Repeat Form in the Office of the Registrar. A course completed with a grade of “C” or higher may not be repeated for a higher grade.

_Dual course credit is not allowed._ All grades earned by the student are a part of her/his official academic record and will appear on her/his transcript. Special authorization may be requested, as needed, from the Dean of the appropriate College/School to assist the student with completing requirements for graduation.

B. ACADEMIC RETENTION

The normal load for an undergraduate student is fifteen (17) credit hours per semester. The minimum load for a full-time undergraduate student is twelve (12) credit hours per semester. The student is expected to make normal progress toward a degree. Normal progress means the completion of sixteen or more semester hours each semester with a 2.0 grade point average or higher for a full-time student. These 15-16 hours must consist of courses that count toward graduation for a full-time student.

A student is eligible to register if he or she has a minimum overall grade point average of 3.0 and has attended the University less than the maximum number of semesters allowed for the degree program.

Freshman or sophomore students whose mid-semester grade point averages are less than 2.0 will be issued an academic warning indicated by a special notation on mid-semester grade reports issued from the Office of the Registrar. While being placed on academic warning does not become a part of the student’s permanent record, the student is warned that failure to restore good academic standing by the end of that semester will result in academic probation.

A student who does not meet the above requirements will be placed on academic probation for the next semester of enrollment and is required to remove the deficiency prior to the beginning of the following semester. Failure to remove this deficiency during the probation
semester will lead to a one-semester suspension. A student who is suspended for a given semester may petition the dean to waive the suspension. The student who has been suspended and re-admitted with a waiver from his or her Dean is required to make a minimum grade point average of 2.0 each semester or summer session following re-enrollment until such time as the minimum cumulative grade point average is at or above the minimum appropriate progression requirement. A student who is on probation at the end of the spring semester may attend summer school and work toward removing his or her academic deficiencies.

Students are expected to be aware at all times of their academic status and to be responsible for knowing whether or not they are on academic probation. Students on academic probation shall be limited to a maximum of twelve (12) credit hours of credit in a fall or spring semester and no more than four (4) credit hours in each session of summer school.

Any student who is placed on academic suspension at the end of the spring semester may attend both sessions of summer school to remove academic deficiencies. However, if the suspended student does not raise his or her average to the required minimum, the student will remain suspended.

A student who fails to meet the minimum academic requirements after having been suspended and re-admitted is subject to permanent academic dismissal. There is an appeal procedure for academic dismissal.

C. INCOMPLETE GRADES

Students are expected to complete all requirements of a particular course during the semester in which they are registered. However, if at the end of the semester, the required course is not complete due to circumstances beyond the control of the student; an “I” could be submitted by the instructor at her/his discretion. The “I” must be removed within the first 6 weeks of the next semester. Students should know that “I” grades that are not removed in time will automatically change to an “F”. Incomplete grades are not encouraged.

Along with the recording of the incomplete grade, the instructor must file with the head of the Department, the student’s average grade and a written description of the work that must be completed before the incomplete grade is removed. Developmental, thesis and research courses are exempted from this six-week time limit. Incomplete grades in prerequisite courses must be removed before registration in the sequence course can be permitted.
D. ACADEMIC DISHONESTY POLICY

The University is committed to a policy of academic honesty for all students. Examples of Academic Dishonesty include but are not limited to:

- Cheating or knowingly assisting another student in committing an act of academic dishonesty;
- Plagiarism (unauthorized use of another person’s words or ideas as one’s own) or self-plagiarism (submitting a previous report of one’s own as a new report) which includes but is not necessarily limited to submitting examinations, theses, reports, drawings, laboratory notes or other materials as one’s own work when such work has been prepared by another person or copied from another person.
- Unauthorized possession of examinations or reserve library materials, destruction or hiding of source materials, library materials, or laboratory materials or experiments or any other similar action;
- Unauthorized changing of grades or marking on an examination or in an instructor’s grade book, or such change of any grade record;
- Aiding or abetting in the infraction of any of the provisions anticipated under the general standards of student conduct; or
- Assisting another student in violating any of the above rules.

A student who has committed an act of academic dishonesty has failed to meet a basic requirement of satisfactory academic performance. Thus, academic dishonesty is not only a basis for disciplinary action but may also affect the evaluation of the student’s level of performance. Any student who commits an act of academic dishonesty is subject to disciplinary action as defined below.

In instances where a student has clearly been identified as having committed an academic act of dishonesty, the instructor may take appropriate punitive action including a loss of credit for an assignment, an examination or project, or awarding a grade of “F” for the course subject to the review and endorsement of the chairperson and the dean. Repeated offenses can lead to dismissal from the University.

E. DISRUPTIVE BEHAVIOR IN THE CLASSROOM

The instructor may withdraw a student from a course for behavior he deems to be disruptive to the class. The grade assigned will be “W” if the behavior occurs before the
deadline for dropping a course without academic penalty, and the instructor has the option of giving a “F” if the behavior occurs after the deadline.

The instructor must provide an opportunity for the student to be heard. In providing this opportunity, the instructor must follow the procedure described below:

- The student should be notified in writing at the next class attended that the instructor proposes to drop the student from the course for disruption of the class, and the instructor should provide the student with written instructions regarding the time and place for a meeting with the instructor. A copy of this written notification must be sent to the instructor’s department head at the same time.

- A time limit of five working days (M-F) from the time of written notification is given for the student’s opportunity to be heard by the instructor.

- The date of notification establishes whether the withdrawn student will be given a “W” or “F.” “W” is appropriate before the 8-week drop date and either “W” or “F” is appropriate after that date, at the instructor’s discretion.

- The instructor may suspend the student from class until the instructor takes final action to withdraw the student from class or to allow the student to continue in the class. The final decision to withdraw or continue the student is the instructor’s.

- Either party in the resolution of this dispute may invite one other person of the University community to be present as an observer.

F. GRADUATION UNDER A GIVEN CATALOG YEAR

A student may expect to earn a degree in accordance with the requirements of the curriculum outlined in the catalog in force when he or she first entered the University, provided the courses are being offered. Moreover, he or she must complete these requirements within six years. In addition, he or she may graduate under any subsequent catalog published while he or she is a student. If a student elects to meet the requirements of a catalog year other than the one in force at the time of his or her original admission, he or she must meet all requirements of the catalog he or she elects.

G. SEMESTER EXAMINATIONS

A final examination will be required as a part of every course. An examination schedule showing the time and meeting place of each course and section will be published each
semester. Schedules so published will be followed without exception. Any changes in the examination schedule must be approved by the Office of Academic Affairs.

H. GRADUATION WITH HONORS

Undergraduate candidates who complete all requirements for graduation in accordance with the following stipulations earn the following honors: (1) Those who maintain a general average within the range of 3.25 to 3.49 will receive CUM LAUDE, (2) those who maintain a general average within the range from 3.5 to 3.74 will receive MAGNA CUM LAUDE, and (3) those who maintain a general average within the range of 3.75 to 4.00 will receive SUMMA CUM LAUDE.

All hours attempted are included in the grade point average computation for honors. This means that when a course is repeated, both grades are added in the computation. For a transfer student a minimum of 70 percent of the credit hours required for a degree program must be earned at the University to be considered for honors. For example, if the program requires a total of 120 credit hours, 70 of those hours must be earned at the University. Publication of honors and scholarships is made at commencement.
APPENDIX A

BIOLOGICAL ENGINEERING FACULTY AND STAFF
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BIOE 114. Home and Farm Maintenance
Credit 3(1-4)
This course provides instruction in the selection, sharpening, care and correct use of shop tools and equipment; woodworking and simple carpentry; simple electrical repairs; sheet metal work; electric arc and oxyacetylene welding; pipe fitting and simple plumbing repairs. (S)

BIOE 121. Introduction to BIOE
Credit 1(1-0)
Introduction to the major and the profession of Biological Engineering. Professionalism, engineering ethics and responsible conduct, project management, working in a team, communication, and use of technology and innovation in problem solving. Global contemporary issues in Biological Engineering including climate change, food-water-energy nexus, sustainability, and global awareness. (F)

BIOE 204. Principles and Applications of Land Surveying
Credit 3 (1-4)
This course covers basic surveying knowledge, theories and practices of plane and topographic surveying, measurements (accuracy and errors), differential and profile leveling, stadia traverse, and an introduction to site planning and development. The integration of Global Positioning Systems along with field layout, orientation, land leveling and water management (Irrigation and Drainage) will be emphasized, horizontal and vertical roadway layout will also be discussed. Prerequisites: MATH 102 or 110 or 131. (F)

BIOE 216. Geographic Information Systems
Credit 3(1-4)
This course introduces Geographic Information System (GIS) concepts and applications. GIS theory is presented, and hands-on exercises are used to demonstrate the application and use of GIS in agriculture, arts and sciences, health, political sciences, engineering, technology, and other disciplines. (S)

BIOE 320 Heat Mass Transfer
Credit 3(1-4)
Catalog description: This course covers the basic principles of heat and mass transfer applied to biological systems. The subjects of heat and mass transfer will be taught in conjunction with agricultural, biological and environmental engineering fields. Specific topics include governing equations and boundary conditions of heat and mass transfer, heat and mass transfer in living systems, steady and unsteady transport phenomena and numerical methods. (S)

BIOE 330. Engineering Systems Analysis and Design
Credit 3(2-2)
This course introduces the analysis and the design of engineering systems. Concepts, methods, and procedures associated with the engineering design process are studied. Specific topics include project management; customer need identification; team behavior; concept generation and evaluation; embodiment design; modeling and simulation; finite element analysis software; material selection; engineering statistics; and legal and ethical issues in design. Prerequisites: CAAE 332 or MEEN 336 or equivalent. (S)

BIOE 332. Physical and Engineering Properties of Soil (formerly BIOE 432)
Credit 3(2-2)
This course addresses fundamental principles of laws which govern the movement or behavior of water and air in soils. The impact of soil physical and biological properties on drainage and irrigation design are discussed. Discussion will also include stream restoration, compaction and mechanics of soil materials. Prerequisite: CAAE 364 or equivalent. (S)

BIOE 340. Engineering Properties of Biological Materials (formerly BIOE 440)
Credit 3(2-2)
This course covers engineering properties of plant and animal materials. Specific topics include structure and composition of plant and animal materials, elastic and viscoelastic properties, food rheology and thermal properties, aerodynamic and hydrodynamic properties, and electromagnetic properties. Prerequisites: BIOL 101 or equivalent; CAAE 332 or and MEEN 336 or equivalent. (F)
BIOE 360. General Hydrology  
Credit 3(2-2)
This course is an introduction to the study of surface and subsurface hydrology. Topics include hydrologic cycle, rainfall-runoff relationships, precipitation measurements and hydrographs, unit hydrograph analysis, flood routing, planning and design of runoff/detention systems, and computer applications in hydrology. Prerequisites: CAAE 362 or MEEN416. (F)

BIOE 400. Soil and Water Engineering  
Credit 3(2-2)
This course emphasizes the application of hydraulics, hydrology, saturated flow, engineering principles, and soil and plant Properties in the analysis and design of soil and water management systems. Topics include water quality, precipitation, overland flow and erosion, states of flow, equation of flow, irrigation and drainage designs, and pipe flow. Additional discussions will include ways to improve conservation engineering commonly used; as well as the transfer of technology to agriculture, engineering and other related disciplines. Prerequisite: CAAE 364, BIOE 360 or equivalent. (F)

BIOE 403. Power and Machinery  
Credit 3(2-2)
This course covers the design principles of field machinery, evaluation of functional performance, and the efficiency of these machines. Also considered is the thermal analysis of internal combustion engines. Measurement and calculation of tractive and engine powers are included. Prerequisites: CAAE 332 or MEEN 336 or equivalent. (F;S)

BIOE 404. Structures and the Environment  
Credit 3(1-4)
This course covers the fundamentals of timber-framed building design and construction. Topics include, selection of materials, design of foundations, beams and columns, reinforced concrete, and environmental considerations, such as temperature, humidity, condensation, and ventilation. Prerequisite: CAAE 332 or MEEN 336 or equivalent. (F;S)

BIOE 415. Water Management and Conservation  
Credit 3(3-0)
The primary purpose of the course is to examine basic concepts and practices dealing with water issues, agricultural pollutants, irrigation and drainage water conservation methods, and design and evaluation of water management systems at the field and water shed scale. This course will review basic principles of hydrology, erosion, saturated and unsaturated flow, soil-water-air-plant relationships, land leveling and development. Prerequisites: SLMG 200 or equivalent and Senior standing in Biological Engineering. (F;S)

BIOE 422. Introduction to Bioprocess Engineering  
Credit 3(3-0)
This course covers the engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Emphasis is placed on energy balance, material balance, fluid flow and mixing, heat and mass transfer, bioreaction kinetics, design, analysis, instrumentation, and control of bioreactors. Prerequisites: BIOE 330 or equivalent. (F;S)

BIOE 423. Fundamentals of Renewable Energy Systems  
Credit 3(2-2)
This course discusses the production, utilization, and design of renewable energy systems. Specific topics include: heat transfer, heat exchangers, solar (thermal and photovoltaic) energy, biogas, biomass, bioethanol, gasification and pyrolysis, energy analysis, sustainability, air pollution and ethics. Prerequisite: MEEN 441 or CHEN 312. (S)

BIOE 424. Water Resources Engineering  
Credit 3(2-2)
This course emphasizes the analysis and design of water resources systems. Topics include water resources planning and development, hydraulic structures, open channel flow, introduction to aquifer analysis and contamination, well development, pumps and pumping, pipe flow, water supply quantity and quality, best management practice, water laws, watershed models (SWAT) and flood plain models (HEC-RAS). Prerequisite: CAAE 364 or equivalent, or BIOE 400. (S)

BIOE 425. Instrumentation for Biological Systems  
Credits 3(1-4)
Basic concepts of instrumentation for monitoring of biological systems will be studied. Specific topics include: selection and use of sensors and data acquisition systems for measuring various parameters of biological systems (temperature, pressure, flow and pH value) monitoring and control of bioreactors, analytic instruments for measuring cells and biomolecules (light and fluorescent microscopes, GC-MS, HPLC and elemental analyzer) and analysis of experimental data. Prerequisites: BIOE 330. (S)
BIOE 426. Food Engineering (Formerly BIOE 522) Credit 2(2-2)
The general engineering principles of solids, fluids, and process equipment are discussed. Topics include energy, heat, enthalpy, psychrometrics, heat and mass transfer, drying and refrigeration of food products. Prerequisite: CHEM 107. (F;S)

BIOE 432. Physical and Engineering Properties of Soil Credit 3(2-2)
This course addresses the fundamental principles of soil physical properties and processes; movement of water in soil; soil dynamics; measurement and analysis of soil physical properties and processes; methods of analysis applicable to solving practical problems related to agricultural, hydrological and environmental problems. Prerequisites: CAEE 364 or BIOE 360 and BIOE 400 or Consent of Instructor. (S)

BIOE 434. Ecological Engineering Credit 3(1-4)
This course covers principles of ecological engineering design for integration into society and the environment for benefit of both. The principles are followed by the applications of ecological engineering to treat wastewaters, and to restore ecosystems. Some of the major technologies covered are treatment wetlands, land application, phytoremediation, stormwater BMPs, and stream restoration. Students will be able to integrate knowledge of engineering, mathematics, ecology and biology to solve complex environmental problems that arise from interaction of human with their environment. These solutions will be environmentally friendly, socially acceptable and economically feasible for sustainability. Lectures are complemented by discussions, case studies, presentations, videos, assignments, and problem solving. (F)

BIOE 440. Eng Prop Biological Material Credit 3(2-2)
This course covers engineering properties of plant and animal materials. Specific topics include structure and composition of plant and animal materials, elastic and viscoelastic properties, food rheology and thermal properties, aerodynamic and hydrodynamic properties, and electromagnetic properties. Prerequisites: BIOL 101 or equivalent; CAAE 332 or MEEN 336 or equivalent. (F;S)

BIOE 485. Selected topics in Biological Engineering (formerly BIOE 505) Credit 3(3-0)
An in-depth lecture course covering several advanced topics in Biological Engineering. Topics are selected to match student interest and faculty expertise. A specific course description will be made available at the time such a course is offered. Prerequisite: Senior standing in Biological Engineering. (F;S)

BIOE 490. Independent Study in Biological Engineering (formerly BIOE 510) Credit 1-3(0-6)
An independent study course is completed on a single topic in Biological Engineering. Topics are selected to fit the mutual interests of students and faculty advisor. The study includes the design of an apparatus, a process, or a procedure. Final written report and an oral presentation of the work are required. Prerequisites: Permission of Instructor. (F;S)

BIOE 495. Engineering Design I (formerly BIOE 501) Credit 1(1-0)
In this course, each student identifies a design project, defines the problem, collects all required resources and databases and outline the work plan. This project integrates design concepts from previous courses. Prerequisite: BIOE 330. (F)

BIOE 496. Engineering Design II (formerly BIOE 502) Credit 2(2-0)
In this course students complete the work plan established in BIOE 495. Prerequisite: BIOE 495. (S)
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** A grade of “C” or above is required

**BIOE Electives:** BIOE 404, BIOE 415, BIOE 426, BIOE 450, BIOE 485, BIOE 490, CIEN 310 or other senior level courses approved by the faculty advisor. **Statistics Electives:** MATH 224, ECON 305, ISEN 370, and CAEE 304
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**Grand Total 120**

**A grade of “C” or above is required.**

**BIOE Electives:**
- BIOE 404, BIOE 432, BIOE 422, BIOE 485, BIOE 490, CIEN 310 or other senior level courses approved by the faculty advisors.

**Statistics Electives:**
- MATH 224, ECON 305, ISEN 370, and CAEE 304
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### TABLE 5.4 BIOLOGICAL ENGINEERING CURRICULUM – PREREQUISITE TABLE
(Bioprocessing Engineering Track)
Prerequisites Are Listed Below Each Course

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<th>1st YR Fall</th>
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