## Second Semester
4 - CH 1020 General Chemistry  
3 - ENGR 1410 Programming and Problem Solving*  
4 - MATH 1080 Calculus of One Variable II  
4 - PHYS 1220 Physics with Calculus I  
3 - Arts and Humanities Requirement or  
1 - Social Science Requirement  
1 - Biology Requirement  

## Sophomore Year
### First Semester
3 - BIOE 2010 Intro. to Biomedical Engineering  
3 - CH 2010 Survey of Organic Chemistry  
4 - MATH 2060 Calculus of Several Variables  
3 - MSE 2100 Introduction to Materials Science  
3 - PHYS 2210 Physics with Calculus II  

### Second Semester
0 - BIOE 2000 Bioengineering Professional Development  
3 - BIOE 3200 Biotechnologies  
3 - CE 2010 Statics  
2 - ECE 2070 Basic Electrical Engineering  
1 - ECE 2080 Basic Electrical Engineering Lab.  
2 - ENGR 2080 Engineering Graphics and Machine Design  
4 - MATH 2080 Intro. to Ordinary Diff. Equations  

## Junior Year
### First Semester
3 - BIOE 3200 Biomechanics  
4 - BIOL 3150 Functional Human Anatomy  
3 - MSE 3190 Materials Processing I  
3 - MSE 3260 Thermodynamics of Materials  
3 - MSE 3270 Transport Phenomena  

### Second Semester
3 - BCHM 3050 Essential Elements of Biochem.  
0 - BIO 3000 Bioengineering Ethics and Entrepreneurship  
3 - BIOE 3210 Biofluid Mechanics  
3 - BIOE 3720 Biomedical Image Processing and Bioimaging  
3 - MATH 3202 Statistics for Science and Engr.  
3 - Bioengineering Technical Requirement  

## Senior Year
### First Semester
3 - BIOE 4010 Bioengineering Design Theory  
3 - BIOL 4610 Cell Biology  
3 - MSE 4150 Intro. to Polymer Science and Engr.  
3 - Arts and Humanities Requirement or  
3 - Social Science Requirement  
3 - Bioengineering Technical Requirement  

### Second Semester
1 - BIOE 4000 Bioengineering Leadership and MedTech Commercialization  
3 - BIOE 4030 Applied Biomedical Design  
3 - BIOE 4480 Tissue Engineering  
3 - Arts and Humanities Requirement or  
3 - Social Science Requirement  
6 - Bioengineering Technical Requirement  

128 Total Semester Hours

*ENGR 1050 and 1060 may be substituted for ENGR 1020  
*See Policy on Humanities and Social Sciences for Engineering Curricula. Six of these credit hours must also satisfy General Education Cross-Cultural Awareness and Science and Technology in Society Requirements.  
*ENGR 1070, 1080 and 1090 may be substituted for ENGR 1410  
*Students planning to enter medical school should take CH 2230/2270 instead of CH 2010/2020 and take CH 2240/2280 as an additional course sequence. Students planning to enter medical school should also take physics laboratories as additional courses (PHYS 1220 course with PHYS 1240 lab and PHYS 2210 course with PHYS 2230 lab).  
*Select from BIOE 1010, BIOL 1030, 1040, 1100, 1110  
*Students must take at least six credits from courses with a lecture designation. The other six credits may be selected from courses with the lecture or the non-lecture designation.  

### Lecture Courses—BIOE 3210, 4020, 4120, 4150, 4230, 4310, 4330, 4400, 4490, 4500, 4610, 4670, 4680, BMOL 4250, 4260, ECE 2270/2730, 3170, 3210/3220, 3710/3720, 3810, 4090, 4200, 4270, 4320, 4670, MATH 3650, MSE 4580, PHYS 4170  

### Non-Lecture Courses—BIOE 4510, 4600, 4690, 4900, 4910  

Note: To transfer from General Engineering into the Bioengineering degree program, students must have a minimum cumulative grade-point average of 3.0 in courses taken at Clemson and must have earned a C or better in each course in the General Engineering freshman curriculum including the Arts and Humanities/Social Science Requirements.

### BIOSYSTEMS ENGINEERING

**Bachelor of Science**

Biosystems engineering is the field of engineering most closely allied with advances in biology. Bioengineering engineers apply engineering design and analysis to biological systems and incorporate fundamental biological principles to design and achieve ecological balance.

The Biosystems engineering program emphasizes two main areas – sustainable bioprocess engineering, with its basis in microbiology, and ecological engineering, with its basis in ecology. Bioprocess engineering focuses on the sustainable production of bioenergy compounds - biofuels, nutraceuticals, bioactive molecules, and biomaterials - using metabolic pathways found in nature and green processing technologies. Ecological engineering focuses on the design of sustainable communities utilizing low-impact development strategies such as bioretention basins, rainwater harvesting, and bioswales for stormwater retention, treatment, and management. Both emphasis areas interface with ecologically-sound food and energy crops and feedstock production systems.

Biosystems engineers lead teams to:
- Design bioprocesses and systems for biofuels (biodiesel, hydrogen, ethanol), biopharmaceutical, bioplastics, and food processing industries
- Develop ecological designs (permeable pavement, bioswales, green infrastructure) to integrate stormwater management into the landscape
- Integrate biological sustainability into energy, water, and food systems
- Provide engineering expertise for agriculture, food processing, and manufacturing industries

Biosystems engineering graduates are highly qualified to pursue graduate studies in biosystems engineering, biomedical engineering and ecological engineering fields, or medical and veterinary school. Those interested in medical school can fulfill premedical course requirements with the Biosystems Engineering BS degree.

 Additional information is available from the departmental offices or at: http://www.clemson.edu/majors/biosystems-engineering.

### Combined Bachelor’s/Master’s Program

Under this plan, students may reduce the time necessary to earn both degrees by applying graduate credits to both undergraduate and graduate program requirements.

Undergraduate students in Biosystems Engineering may begin a Master of Science Degree in Environmental Engineering and Science or Master of Science Degree in Biosystems Engineering while completing the BS degree.

Students are encouraged to obtain the specific requirements for the dual degree from the academic departments involved as early as possible in their undergraduate program. See Academic Regulations in this catalog for enrollment guidelines and procedures.

### Freshman Year

**First Semester**
4 - CH 1010 General Chemistry  
3 - ENGL 1030 Composition and Rhetoric  
2 - ENGR 1020 Engineering Disciplines and Skills  
4 - MATH 1060 Calculus of One Variable I  
3 - Arts and Humanities Requirement or  
3 - Social Science Requirement  

**Second Semester**
4 - CH 1020 General Chemistry  
3 - ENGR 1410 Programming and Problem Solving  
2 - ENGR 2100 Computer-Aided Design and Engineering Applications  
4 - MATH 1080 Calculus of One Variable II  
3 - PHYS 1220 Physics with Calculus I  

### Sophomore Year

**First Semester**
2 - BE 2100 Fundamentals of Biosystems Engr.  
3 - CE 2010 Statics  
4 - MATH 2060 Calculus of Several Variables  
3 - PHYS 2210 Physics with Calculus II  
4 - Biology Requirement  

**Second Semester**
2 - BE 2100 Intro. to Biosystems Engineering  
2 - CE 2080 Dynamics  
4 - MATH 2080 Intro. to Ordinary Diff. Equations  
3 - ME 3100 Thermodynamics and Heat Transfer  
4 - MICR 3050 General Microbiology  

### Junior Year

**First Semester**
3 - BE 3200 Principles and Practices of Geomatics  
3 - BE 4100 Biol. Kinetics and Reactor Modeling  
3 - BIOL 4410 Ecology  
4 - CE 3410 Introduction to Fluid Mechanics  
2 - ECE 2070 Basic Electrical Engineering  
1 - ECE 2080 Basic Electrical Engineering Lab.  

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Second Semester
3 - BE 3220 Small Watershed Hydrology and Sedimentology
3 - BE 4120 Heat and Mass Transport in Biosystems Engineering
3 - BE 4150 Instrumentation and Process Control for Biosystems Engineering
3 - BE 4380 Bioprocess Engineering Design
3 - CH 2230 Organic Chemistry
1 - CH 2270 Organic Chemistry Laboratory
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*ENGR 1050 and 1060 may be substituted for ENGR 1020
2Students should choose courses to fulfill General Education requirements including Humanities, Social Science, Cross-Cultural Awareness and Science and Technology in society components. See Undergraduate Announcements and academic advisor for details.
3*ENGR 1070, 1080, and 1090 may be substituted for ENGR 1140
*ME 2010 may be substituted for CE 2010 and 2080
*BIOI 1030/1050 or 1100

BIOPROCESS ENGINEERING EMPHASIS AREA
Senior Year
First Semester
3 - BCHM 3050 Biochemistry
3 - BE 4280 Biochemical Engineering
2 - BE 4740 Biosystems Engr. Design/Project Mgt.
2 - BE 4750 Biosystems Engr. Capstone Design
2 - BIOL 4340 Biol. Chemical Lab. Techniques
4 - CE 2060 Structural Mechanics
16
Second Semester
9 - Arts and Humanities Requirement2 or Social Science Requirement2
9 - Engineering Requirement4
3 - Global Sustainability Requirement
15
126 Total Semester Hours

*Select from BE 3140, 4080, 4140, 4170, 4220, 4400, 4640, 4730, 4840, CE 3120, 3520, 4020, 4060, 4820, EES 4010, 4020, 4030, 4800, 4840, 4850, 4860, GEOL 4210, IE 3840, or any 3000-4000 level ENGR course.

*Select any course from Sustainability Minor course list.

ECOLOGICAL ENGINEERING EMPHASIS AREA
Senior Year
First Semester
2 - BE 4210 Engineering Systems for Soil Water Management
2 - BE 4740 Biosystems Engr. Design/Project Mgt.
2 - BE 4750 Biosystems Engr. Capstone Design
4 - CE 2060 Structural Mechanics
3 - Arts and Humanities Requirement or Social Science Requirement
3 - Ecological Requirement
16
Second Semester
3 - BE 4240 Ecological Engineering
6 - Arts and Humanities Requirement or Social Science Requirement
3 - Engineering Requirement
3 - Global Sustainability Requirement
15
126 Total Semester Hours

*Ecological Requirement: Choose from 3000 level or higher courses in BIOL, FOR, HORT, MICR, PES, or WFB
Select from BE 3410, 4080, 4140, 4170, 4220, 4400, 4640, 4730, 4840, CE 3120, 3520, 4020, 4060, 4820, EES 4010, 4020, 4030, 4800, 4840, 4850, 4860, GEOL 4210, IE 3840, or any 3000-4000 level ENGR course.

*Select any course from Sustainability Minor course list.

CHEMICAL ENGINEERING Bachelor of Science
The Department of Chemical and Biomolecular Engineering offers the Bachelor of Science degree in Chemical Engineering. Chemical Engineering students select one of several emphasis areas (such as energy studies or environmental engineering), a concentration in Biomolecular Engineering (to prepare them for medical school or a career in biotechnology), or any approved minor.

Chemical engineering is based on chemistry, biology, physics, and mathematics. The curriculum at Clemson includes classroom and laboratory instruction and emphasizes broadly applicable fundamental principles and current technology to prepare graduates for professional practice and professional growth. The Educational Objective of the BS degree program is for graduates to have careers characterized by:

- success in chemical engineering practice, postgraduate education, or other areas making use of engineering skills, as defined by accomplishments and/or job satisfaction;
- demonstrated success in the design of chemical processes and/or identification, formulation, and solution of chemical engineering problems;
- ethical behavior in all endeavors;
- demonstrated effectiveness in teamwork, communication, and service to society through professional contributions;
- demonstrated technical and/or managerial leadership;
- demonstrated commitment to lifelong learning.

Chemical engineers are involved in the research, manufacture, sales, and use of commodity and specialty chemicals, fuels, pharmaceuticals, electronic components, synthetic fibers and textiles, food and consumer goods, and many other products. They work on environmental pollution prevention and remediation and apply engineering science to solve medical and health-related problems.

Combined Bachelor of Science/Master of Science
Qualified students can reduce the time to earn a Master’s Degree by applying graduate credits to both the Bachelor’s and Master’s program requirements. Undergraduate Chemical and Biomolecular Engineering students who have earned a grade point average of 3.4 or above and completed 90 credit hours can begin work toward a Master of Science in Chemical Engineering or a Master of Science in Environmental Engineering and Science by selecting approved graduate courses for their emphasis area. Details are available in the ChBE Undergraduate Handbook, which can be found at www.clemson.edu/ces/chbe.

Freshman Year
First Semester
4 - CH 1010 General Chemistry
3 - ENGL 1030 Composition and Rhetoric
2 - ENGR 1020 Engineering Disciplines and Skills
4 - MATH 1060 Calculus of One Variable I
3 - Arts and Humanities Requirement or Social Science Requirement

Second Semester
4 - CH 1020 General Chemistry
3 - CHE 1300 Intro to Chemical Engineering
4 - MATH 1080 Calculus of One Variable II
3 - PHYS 1220 Physics with Calculus I
3 - Arts and Humanities Requirement or Social Science Requirement

Sophomore Year
First Semester
3 - CH 2230 Organic Chemistry
4 - CHE 2110 Mass and Energy Balances
4 - MATH 2060 Calculus of Several Variables
3 - PHYS 2210 Physics with Calculus II
3 - Arts and Humanities Requirement or Social Science Requirement

Second Semester
3 - CH 2240 Organic Chemistry
1 - CH 2290 Organic Chemistry Lab.
3 - CHE 2220 Chemical Engr. Thermodynamics I
4 - CHE 2300 Fluids/Heat Transfer
4 - MATH 2080 Intro. to Ordinary Diff. Equations

Junior Year
First Semester
1 - CH 3390 Physical Chemistry Lab.
3 - CHE 3210 Chemical Engr. Thermodynamics II
4 - CHE 3300 Mass Transfer and Separation Proc.
2 - ECE 2070 Basic Electrical Engineering
1 - ECE 2080 Basic Electrical Engineering Lab.
3 - STAT 4110 Statistical Methods for Process Development and Control
3 - Emphasis Area Requirement

Second Semester
3 - BMOL 4250 Biomolecular Engineering
3 - CH 3320 Physical Chemistry
1 - CH 3400 Physical Chemistry Lab.
3 - CHE 3070 Unit Operations Lab. I
3 - CHE 3190 Engineering Materials
3 - Arts and Humanities Requirement or Social Science Requirement

Senior Year
First Semester
3 - CHE 4070 Unit Operations Lab. II
3 - CHE 4310 Chemical Process Design I
2 - CHE 4430 Safety, Environ & Prof Practice I
3 - CHE 4500 Chemical Reaction Engineering
3 - Arts and Humanities Requirement or Social Science Requirement
3 - Emphasis Area Requirement

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