

# MAJOR IN CHEMICAL AND BIOLOGICAL ENGINEERING, SUSTAINABLE ENGINEERING CONCENTRATION

## Requirements Effective Fall 2024

Students may enroll in either the standalone major or (at most) one of the concentrations under the Major in Chemical and Biological Engineering.

### Freshman

|                                      |                                                                     | AUCC | Credits   |
|--------------------------------------|---------------------------------------------------------------------|------|-----------|
| CBE 160                              | MATLAB for Chemical and Biological Eng                              |      | 1         |
| CHEM 111                             | General Chemistry I (GT-SC2)                                        | 3A   | 4         |
| CHEM 112                             | General Chemistry Lab I (GT-SC1)                                    | 3A   | 1         |
| CHEM 113                             | General Chemistry II                                                |      | 3         |
| CHEM 114                             | General Chemistry Lab II                                            |      | 1         |
| CO 150                               | College Composition (GT-CO2)                                        | 1A   | 3         |
| LIFE 102                             | Attributes of Living Systems (GT-SC1)                               | 3A   | 4         |
| MATH 160                             | Calculus for Physical Scientists I (GT-MA1)                         | 1B   | 4         |
| MATH 161                             | Calculus for Physical Scientists II (GT-MA1)                        | 1B   | 4         |
| PH 141                               | Physics for Scientists and Engineers I (GT-SC1)                     | 3A   | 5         |
| Select one group from the following: |                                                                     |      | 3         |
| Group A:                             |                                                                     |      |           |
| CBE 101                              | Introduction to Chemical and Biological Engr                        |      |           |
| Group B:                             |                                                                     |      |           |
| CBE 101A                             | Introduction to Chemical and Biological Engr: Lecture               |      |           |
| CBE 101B                             | Introduction to Chemical and Biological Engr: Laboratory            |      |           |
| Group C:                             |                                                                     |      |           |
| CBE 104A                             | Study Abroad--Denmark: Intro to Chemical and Biological Engineering |      |           |
| <b>Total Credits</b>                 |                                                                     |      | <b>33</b> |

### Sophomore

|                                                                                                                                                                                                                                                                              |                                                  |    |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|----|-----------|
| CBE 201                                                                                                                                                                                                                                                                      | Material and Energy Balances                     |    | 3         |
| CBE 205                                                                                                                                                                                                                                                                      | Fundamentals of Biological Engineering           |    | 3         |
| CBE 210                                                                                                                                                                                                                                                                      | Thermodynamic Process Analysis                   |    | 3         |
| CHEM 341                                                                                                                                                                                                                                                                     | Modern Organic Chemistry I                       |    | 3         |
| CHEM 343                                                                                                                                                                                                                                                                     | Modern Organic Chemistry II                      |    | 3         |
| CHEM 344                                                                                                                                                                                                                                                                     | Modern Organic Chemistry Laboratory              |    | 2         |
| MATH 261                                                                                                                                                                                                                                                                     | Calculus for Physical Scientists III             |    | 4         |
| MATH 340                                                                                                                                                                                                                                                                     | Intro to Ordinary Differential Equations         |    | 4         |
| PH 142                                                                                                                                                                                                                                                                       | Physics for Scientists and Engineers II (GT-SC1) | 3A | 5         |
| Diversity, Equity, and Inclusion ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion</a> ) |                                                  | 1C | 3         |
| <b>Total Credits</b>                                                                                                                                                                                                                                                         |                                                  |    | <b>33</b> |

### Junior

|        |                            |  |   |
|--------|----------------------------|--|---|
| BC 351 | Principles of Biochemistry |  | 4 |
|--------|----------------------------|--|---|

|                                                                                                                                                                                                                                           |                                              |    |   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|----|---|
| CBE 310                                                                                                                                                                                                                                   | Molecular Concepts and Applications          |    | 3 |
| CBE 320                                                                                                                                                                                                                                   | Chemical and Biological Reactor Design       |    | 3 |
| CBE 330                                                                                                                                                                                                                                   | Process Simulation                           |    | 3 |
| CBE 331                                                                                                                                                                                                                                   | Momentum Transfer and Mechanical Separations |    | 3 |
| CBE 332                                                                                                                                                                                                                                   | Heat and Mass Transfer Fundamentals          |    | 3 |
| CBE 393                                                                                                                                                                                                                                   | Professional Development Seminar             |    | 1 |
| Bioscience Elective (see list below)                                                                                                                                                                                                      |                                              |    | 3 |
| Technical Elective (see list below)                                                                                                                                                                                                       |                                              |    | 3 |
| Advanced Writing ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing</a> )  |                                              | 2  | 3 |
| Arts and Humanities ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities</a> ) |                                              | 3B | 3 |

**Total Credits****32****Senior**

|                                                                                                                                                                                                                                                                            |                                               |          |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------|---|
| CBE 333                                                                                                                                                                                                                                                                    | Chemical and Biological Engineering Lab I     |          | 2 |
| CBE 430                                                                                                                                                                                                                                                                    | Process Control and Instrumentation           |          | 3 |
| CBE 442                                                                                                                                                                                                                                                                    | Separation Processes                          |          | 4 |
| CBE 443                                                                                                                                                                                                                                                                    | Chemical and Biological Engineering Lab II    |          | 2 |
| CBE 451                                                                                                                                                                                                                                                                    | Chemical and Biological Engineering Design I  | 4A,4B,4C | 3 |
| CBE 452                                                                                                                                                                                                                                                                    | Chemical and Biological Engineering Design II | 4A,4B,4C | 3 |
| Engineering Elective (see list below)                                                                                                                                                                                                                                      |                                               |          | 3 |
| Technical Elective (see list below)                                                                                                                                                                                                                                        |                                               |          | 3 |
| Arts and Humanities ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities</a> )                                  |                                               | 3B       | 3 |
| Historical Perspectives ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives</a> )              |                                               | 3D       | 3 |
| Social and Behavioral Sciences ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences</a> ) |                                               | 3C       | 3 |

**Total Credits****32****Program Total Credits:****130****Bioscience Electives**

Select a minimum of 3 credits from the following.

| Code            | Title             | Credits |
|-----------------|-------------------|---------|
| LIFE 320        | Ecology           | 3       |
| MIP 432/ESS 432 | Microbial Ecology | 3       |

**Technical Electives**

Select a minimum of 6 credits from the following or select additional credits from the Bioscience Electives or Engineering Electives lists.

| Code      | Title                                                      | Credits |
|-----------|------------------------------------------------------------|---------|
| CHEM 338  | Environmental Chemistry                                    | 3       |
| CHEM 355  | Foundations of Sustainable Chemistry                       | 3       |
| CHEM 465  | Chemistry of Sustainable E-Waste Management                | 1       |
| CHEM 555  | Chemistry of Sustainability                                | 3       |
| CIVE 371  | Study Abroad-Peru: Grand Challenges in Engineering in Peru | 3       |
| ENGR 382B | Study Abroad-Netherlands: Engineering and Sustainability   | 3       |
| ERHS 320  | Environmental Health-Water Quality                         | 3       |

|                  |                                               |   |
|------------------|-----------------------------------------------|---|
| ERHS 410         | Environmental Health-Air and Waste Management | 3 |
| ERHS 446         | Environmental Toxicology                      | 3 |
| ERHS 448         | Environmental Contaminants                    | 3 |
| ESS 311          | Ecosystem Ecology                             | 3 |
| ESS 312          | Sustainability Science                        | 3 |
| ESS 330          | Quantitative Reasoning for Ecosystem Science  | 3 |
| ESS 440          | Practicing Sustainability                     | 4 |
| ESS 501          | Principles of Ecosystem Sustainability        | 3 |
| ESS 524          | Foundations for Carbon/Greenhouse Gas Mgmt    | 3 |
| GES 362          | Systems Thinking and Sustainability           | 3 |
| GES 441          | Analysis of Sustainable Energy Solutions      | 3 |
| GES 465/MSE 465  | Sustainable Strategies for E-Waste Management | 3 |
| GES 528/CIVE 528 | Assessing the Food, Energy, Water Nexus       | 3 |
| GES 542          | Biobased Fuels, Energy, and Chemicals         | 3 |
| NR 319           | Introduction to Geospatial Science            | 4 |
| NR 323/GR 323    | Remote Sensing and Image Interpretation       | 3 |

|          |                                |   |
|----------|--------------------------------|---|
| SOCR 322 | Principles of Microclimatology | 3 |
| SOCR 375 | Soil Biogeochemistry           | 3 |

## Engineering Electives

Select a minimum of 3 credits from the following.

| Code             | Title                                        | Credits |
|------------------|----------------------------------------------|---------|
| ATS 555          | Air Pollution                                | 3       |
| CIVE 330         | Ecological Engineering                       | 3       |
| CIVE 438         | Fundamentals of Environmental Engr           | 3       |
| CIVE 442         | Air Quality Engineering                      | 3       |
| MECH 403         | Energy Engineering                           | 3       |
| MECH 436/MSE 436 | Green Engineering--Materials and Environment | 3       |
| MECH 516         | Life Cycle and Techno-Economic Assessment    | 3       |
| SYSE 530         | Overview of Systems Engineering Processes    | 3       |
| SYSE 532/ECE 532 | Dynamics of Complex Engineering Systems      | 3       |