# DUAL DEGREE PROGRAM:
## BIOMEDICAL ENGINEERING COMBINED WITH CHEMICAL AND BIOLOGICAL ENGINEERING

## Requirements
### Effective Fall 2022

### Freshman

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<tr>
<td>BIOM 100</td>
<td>Overview of Biomedical Engineering</td>
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<td>CBE 160</td>
<td>MATLAB for Chemical and Biological Eng</td>
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<td>CHEM 111</td>
<td>General Chemistry I (GT-SC2)</td>
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<td>CHEM 112</td>
<td>General Chemistry Lab I (GT-SC1)</td>
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<td>General Chemistry II</td>
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<td>Attributes of Living Systems (GT-SC1)</td>
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<td>Calculus for Physical Scientists I (GT-MA1)</td>
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<td>Calculus for Physical Scientists II (GT-MA1)</td>
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<td>PH 141</td>
<td>Physics for Scientists and Engineers I (GT-SC1)</td>
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Select one group from the following:

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

### Total Credits: 30

### Sophomore

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<td>Fundamentals of Biological Engineering</td>
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<td>CBE 210</td>
<td>Thermodynamic Process Analysis</td>
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<td>General Chemistry Lab II</td>
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<td>CHEM 341</td>
<td>Modern Organic Chemistry I</td>
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<td>CHEM 344</td>
<td>Modern Organic Chemistry Laboratory</td>
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<td>Intro to Ordinary Differential Equations</td>
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<td>MECH 262</td>
<td>Engineering Mechanics</td>
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### Total Credits: 33

### Junior

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<td>Problem-Based Learning Biomedical Engr Lab</td>
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<td>BMS 300</td>
<td>Principles of Human Physiology</td>
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<td>CBE 310</td>
<td>Molecular Concepts and Applications</td>
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### Total Credits: 30
Dual Degree Program: Biomedical Engineering combined with Chemical and Biological Engineering

**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

Social and Behavioral Sciences ([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)) 3C

| Total Credits | 31 |

**Senior**

**BIOM 421** Transport Phenomena in Biomedical Engineering 3
**BIOM 422** Quantitative Systems and Synthetic Biology 3
**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 3
**PH 142** Physics for Scientists and Engineers II (GT-SC1) 3A 5
**STAT 315** Intro to Theory and Practice of Statistics 3

BME Broad Elective (see list below) 3

Arts and Humanities ([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)) 3B

| Total Credits | 34 |

**Fifth Year**

**BIOM 486A** Biomedical Design Practicum: Capstone Design I 4A,4B,4C 4
**BIOM 486B** Biomedical Design Practicum: Capstone Design II 4A,4B,4C 4

BME Technical Elective¹ 5

CBE Technical Elective 5

Advanced Writing ([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)) 2 3

Arts and Humanities ([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)) 3B 3

Diversity, Equity, and Inclusion ([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)) 1C 3

Historical Perspectives ([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)) 3D 3

| Total Credits | 30 |

| Program Total Credits: | 158 |

**BME Technical Electives - Select 5 credits**

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<td>BC 404</td>
<td>Comprehensive Biochemistry Laboratory</td>
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<tr>
<td>BC 411</td>
<td>Physical Biochemistry</td>
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<td>BC 463</td>
<td>Molecular Genetics</td>
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<tr>
<td>BC 465</td>
<td>Molecular Regulation of Cell Function</td>
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<td>BC 565</td>
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<td>Study Abroad–Ecuador: Prosthetics</td>
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<td>BIOM 431/ECE 431</td>
<td>Biomedical Signal and Image Processing</td>
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<td>BIOM 441</td>
<td>Biomechanics and Biomaterials</td>
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Select a maximum of 3 credits from the following:

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<td>BIOM 495</td>
<td>Independent Study</td>
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<td>BIOM 518/ECE 518</td>
<td>Biophotonics</td>
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<td>Bioseparation Processes</td>
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<td>Cell and Tissue Engineering</td>
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<td>Biological Physics</td>
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<td>Biosensing: Cells as Circuits</td>
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<td>Biosensing: Signal and Noise in Biosensors</td>
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<td>Biosensing: Sensor Circuit Fundamentals</td>
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### CBE Technical Electives - Select 5 credits

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<td>3D Molecular Models for Biochemistry</td>
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<td>Materials Issues in Mechanical Design</td>
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<td>Biomolecular Tools for Engineers</td>
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<td>Biomedical Signal Processing</td>
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<td>Structure and Function of Biomaterials</td>
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<td>Bio-Inspired Surfaces</td>
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<td>Nerve and Muscle-Toxins, Trauma and Disease</td>
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Dual Degree Program: Biomedical Engineering combined with Chemical and Biological Engineering

ERHS 542 Biostatistical Methods for Qualitative Data 3
ERHS 547 Equipment and Instrumentation 3
F 311 Forest Ecology 3
FTEC 447 Food Chemistry 2
GEOL 150 Physical Geology for Scientists and Engineers 4
GEOL 452 Hydrogeology 4
GEOL 454 Geomorphology 4
GES 441 Analysis of Sustainable Energy Solutions 3
GES 542 Biobased Fuels, Energy, and Chemicals 3
HES 307 Biomechanical Principles of Human Movement 4
HES 319 Neuromuscular Aspects of Human Movement 4
HES 403 Physiology of Exercise 4
HES 420 Electrocardiography and Exercise Management 3
HORT 579 Mass Spectrometry Omics-Methods and Analysis 3
LIFE 201B Introductory Genetics: Molecular/Immunological/Developmental (GT-SC2) 3
LIFE 202B Introductory Genetics Recitation: Molecular 1
LIFE 203 Introductory Genetics Laboratory 2
LIFE 210 Introductory Eukaryotic Cell Biology 3
LIFE 211 Introductory Cell Biology Honors Recitation 1
LIFE 212 Introductory Cell Biology Laboratory 2
LIFE 320 Ecology 3
MATH 301 Introduction to Combinatorial Theory 3
MATH 331 Introduction to Mathematical Modeling 3
MATH 332 Partial Differential Equations 3
MATH 360 Mathematics of Information Security 3
MATH 366 Introduction to Abstract Algebra 3
MATH 369 Linear Algebra I 3
MATH 405 Introduction to Number Theory 3
MATH 419 Introduction to Complex Variables 3
MATH 450 Introduction to Numerical Analysis I 3
MATH 451 Introduction to Numerical Analysis II 3
MATH 455 Mathematics in Biology and Medicine 3
MATH 460 Information and Coding Theory 3
MATH 466 Abstract Algebra I 3
MATH 467 Abstract Algebra II 3
MATH 469 Linear Algebra II 3
MATH 525 Optimal Control 3
MATH 530 Mathematics for Scientists and Engineers 3
MATH 532 Mathematical Modeling of Large Data Sets 3
MATH 535 Foundations of Applied Mathematics 3
MATH 546 Partial Differential Equations II 3
MATH 560 Linear Algebra 3
MECH 307 Mechatronics and Measurement Systems 4
MECH 324 Dynamics of Machines 4
MECH 325 Machine Design 3
MECH 331 Introduction to Engineering Materials 4
MECH 403 Energy Engineering 3
MECH 407 Laser Applications in Mechanical Engineering 3
MECH 424 Advanced Dynamics 3
MECH 425 Mechanical Engineering Vibrations 4
MECH 431 Metals and Alloys 3
MECH 432 Engineering of Nanomaterials 3
MECH 502 Advanced/Additive Manufacturing Engineering 3
MECH 507 Laser Diagnostics for Thermosciences 3
MECH 509 Design and Analysis in Engineering Research 3
MECH 513 Simulation Modeling and Experimentation 3
MECH 524 Principles of Dynamics 3
MECH 527 Hybrid Electric Vehicle Powertrains 3
MECH 529 Advanced Mechanical Systems 3
MECH 530 Advanced Composite Materials 3
MECH 543 Biofluid Mechanics 3
MECH 552 Applied Computational Fluid Dynamics 3
MIP 300 General Microbiology 3
MIP 302 General Microbiology Laboratory 2
MIP 315 Pathology of Human and Animal Disease 3
MIP 334 Food Microbiology 3
MIP 335 Food Microbiology Laboratory 2
MIP 342 Immunology 4
MIP 343 Immunology Laboratory 2
MIP 351 Medical Bacteriology 3
MIP 352 Medical Bacteriology Laboratory 3
MIP 420 Medical and Molecular Virology 4
MIP 425 Virology and Cell Culture Laboratory 2
MIP 432/ESS 432 Microbial Ecology 3
MIP 433/ESS 433 Microbial Ecology Laboratory 1
MIP 443 Microbial Physiology 4
MIP 450 Microbial Genetics 3
MIP 530 Advanced Molecular Virology 4
MIP 543 RNA Biology 3
MIP 550 Microbial and Molecular Genetics Laboratory 4
MIP 555 Principles and Mechanisms of Disease 3
MIP 578/BZ 578 Genetics of Natural Populations 4
MSE 501 Materials Technology Transfer 1
MSE 502A Materials Science & Engineering Methods: Materials Structure and Scattering 1
MSE 502B Materials Science & Engineering Methods: Computational Materials Methods 1
MSE 502C Materials Science & Engineering Methods: Materials Microscopy 1
MSE 502D Materials Science & Engineering Methods: Materials Spectroscopy 1
MSE 502E Materials Science & Engineering Methods: Bulk Properties and Performance 1
MSE 502F Materials Science & Engineering Methods: Experimental Methods for Materials Research 1
MSE 503 Mechanical Behavior of Materials 3
A maximum of 3 credits may be selected from the following courses:

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**BME Broad Electives – Select 3 credits**

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<td>Gödel’s Incompleteness Theorems</td>
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1. Select a total of 5 credits from Approved BME Technical Electives for BME+CBE Program. A maximum of 3 total credits of BIOM 476A, BIOM 476B, and BIOM 495 may count as BME Technical Elective credit.

### Major Completion Map

#### Distinctive Requirements for Degree Program:

**TO DECLARE MAJOR:** Engineering is a controlled major: students are admitted into the major only if they meet established academic standards. Please see competitive major requirements or the advisor in the Department for more information.

**TO PREPARE FOR FIRST SEMESTER:** The curriculum for this major assumes students enter college prepared to take calculus and chemistry. To qualify for graduation, students in the biomedical engineering combined with chemical and biological engineering program must achieve a minimum 2.000 grade point average at CSU in all courses in
Dual Degree Program: Biomedical Engineering combined with Chemical and Biological Engineering

engineering, mathematics, computer science, statistics, physics, and chemistry as well as courses taken as technical electives.

<table>
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<tr>
<th>Freshman</th>
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<td>General Chemistry I (GT-SC2)</td>
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<td>LIFE 102</td>
<td>Attributes of Living Systems (GT-SC1)</td>
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<td>Group A:</td>
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<td>College Composition (GT-CO2)</td>
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<td>CBE 210</td>
<td>Thermodynamic Process Analysis</td>
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<td>CHEM 343</td>
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<td>Intro to Ordinary Differential Equations</td>
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<td>Principles of Human Physiology</td>
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<td>CBE 310</td>
<td>Molecular Concepts and Applications</td>
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<td>CBE 330</td>
<td>Process Simulation</td>
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<tr>
<td>CBE 331</td>
<td>Momentum Transfer and Mechanical Separations</td>
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<td>STAT 315</td>
<td>Intro to Theory and Practice of Statistics</td>
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<tr>
<td>BC 351</td>
<td>Principles of Biochemistry</td>
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<td>BIOM 300</td>
<td>Problem-Based Learning Biomedical Engr Lab</td>
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<td>CBE 320</td>
<td>Chemical and Biological Reactor Design</td>
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CBE 332  Heat and Mass Transfer Fundamentals  X  3
CBE 393  Professional Development Seminar  X  1
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)  3C  3

| Total Credits | 18 |

**Senior**

**Semester 7**

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<tr>
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<td>CBE 333  Chemical and Biological Engineering Lab I</td>
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<td>CBE 442  Separation Processes</td>
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<td>CBE 451  Chemical and Biological Engineering Design I</td>
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| Total Credits | 15 |

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<td>CBE 430  Process Control and Instrumentation</td>
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<td>CBE 443  Chemical and Biological Engineering Lab II</td>
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| Total Credits | 16 |

**Fifth Year**

**Semester 9**

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<td>CBE Technical Elective (See List on Requirements Tab)</td>
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<td>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>)</td>
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| Total Credits | 15 |

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<td>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>)</td>
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<td>The benchmark courses for the 10th semester are the remaining courses in the entire program of study</td>
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| Total Credits | 15 |

| Program Total Credits: | 158 |