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

## Requirements
## Effective Fall 2025

**Freshman**

| | | AUCC | Credits |
|---|---|---|---|
| CHEM 120 | Foundations of Modern Chemistry (GT-SC2) | 3A | 4 |
| CHEM 121 | Foundations of Modern Chemistry Laboratory (GT-SC1) | 3A | 1 |
| CO 150 | College Composition (GT-CO2) | 1A | 3 |
| ENGR 114 | Engineering for Grand Challenges | | 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 |
| Select one group from the following: | | | 3 |
| Group A: | | | |
| ENGR 111 | Fundamentals of Engineering | | |
| Group B: | | | |
| CBE 101 | Introduction to Chemical and Biological Engr | | |
| Group C: | | | |
| CBE 101A | Introduction to Chemical and Biological Engr: Lecture | | |
| CBE 101B | Introduction to Chemical and Biological Engr: Laboratory | | |
| CBE 160 | MATLAB for Chemical and Biological Eng | | |
| Group D: | | | |
| CBE 104A | Study Abroad--Denmark: Intro to Chemical and Biological Engineering | | |
| Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences) | | 3C | 3 |
| | **Total Credits** | | **29** |

**Sophomore**

| | | | |
|---|---|---|---|
| CBE 201 | Material and Energy Balances | | 3 |
| CBE 205 | Fundamentals of Biological Engineering | | 3 |
| CBE 210 | Thermodynamic Process Analysis | | 3 |
| CBE 223 | CBE Design and Experimentation I | | 2 |
| CBE 393 | Professional Development Seminar | | 1 |
| CHEM 241 | Foundations of Organic Chemistry | | 4 |
| CHEM 242 | Foundations of Organic Chemistry Laboratory | | 1 |
| MATH 261 | Calculus for Physical Scientists III | | 4 |
| MATH 340 | Intro to Ordinary Differential Equations | | 4 |
| PH 141 | Physics for Scientists and Engineers I (GT-SC1) | 3A | 5 |
| | **Total Credits** | | **30** |

**Junior**

| | | | |
|---|---|---|---|
| BIOM 300 | Problem-Based Learning Biomedical Engr Lab | | 4 |

| | | | |
|---|---|---|---|
| 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 334 | CBE Design and Experimentation II | | 1 |
| CBE 335 | CBE Design and Experimentation III | | 1 |
| CBE 340 | Statistics for CBE Applications | | 3 |
| MECH 262 | Engineering Mechanics | | 4 |
| Select one of the following courses: | | | 4 |
| BC 351 | Principles of Biochemistry | | |
| BMS 300 | Principles of Human Physiology | | |
| Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities) | | 3B | 3 |
| | **Total Credits** | | **32** |

**Senior**

| | | | |
|---|---|---|---|
| BIOM 421 | Transport Phenomena in Biomedical Engineering | | 3 |
| BIOM 422 | Quantitative Systems and Synthetic Biology | | 3 |
| 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 |
| BME Broad Elective (see list below) | | | 3 |
| Chemistry Elective (see list below) | | | 3 |
| Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing) | | 2 | 3 |
| Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives) | | 3D | 3 |
| | **Total Credits** | | **35** |

**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 |
| Select one of the following courses (one that you have not taken previously): | | | 4 |
| BC 351 | Principles of Biochemistry | | |
| BMS 300 | Principles of Human Physiology | | |
| BME Technical Elective | | | 5 |
| CBE Technical Elective | | | 5 |
| Chemistry Elective (see list below) | | | 3 |
| 1C (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#aucc) | | 1C | 3 |
| Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities) | | 3B | 3 |
| | **Total Credits** | | **31** |
| | **Program Total Credits:** | | **157** |

## BME Technical Electives - Select 5 credits

| Code | Title | Credits |
|---|---|---|
| BC 401 | Comprehensive Biochemistry I | 3 |
| BC 403 | Comprehensive Biochemistry II | 3 |
| BC 404 | Comprehensive Biochemistry Laboratory | 2 |
| BC 411 | Physical Biochemistry | 4 |
| BC 463 | Molecular Genetics | 3 |
| BC 465 | Molecular Regulation of Cell Function | 3 |
| BC 565 | Molecular Regulation of Cell Function | 4 |
| BIOM 304 | Global Challenges and Collaborations in BME | 3 |
| BIOM 350A | Study Abroad--Ecuador: Prosthetics | 1-3 |
| BIOM 431/ECE 431 | Biomedical Signal and Image Processing | 3 |
| BIOM 441 | Biomechanics and Biomaterials | 3 |

| | | |
|---|---|---|
| Select a maximum of 3 credits from the following: | | |
| BIOM 476 | Biomedical Engineering Clinical Practicum | |
| BIOM 495 | Independent Study | |
| BIOM 504/CBE 504 | Fundamentals of Biochemical Engineering | 3 |
| BIOM 518/ECE 518 | Biophotonics | 3 |
| BIOM 522/CBE 522 | Bioseparation Processes | 3 |
| BIOM 525/MECH 525 | Cell and Tissue Engineering | 3 |
| BIOM 526/ECE 526 | Biological Physics | 3 |
| BIOM 527A/ ECE 527A | Biosensing: Cells as Circuits | 1 |
| BIOM 527B/ ECE 527B | Biosensing: Signal and Noise in Biosensors | 1 |
| BIOM 527C/ ECE 527C | Biosensing: Sensor Circuit Fundamentals | 1 |
| BIOM 527D/ ECE 527D | Biosensing: Electrochemical Sensors | 1 |
| BIOM 527E/ ECE 527E | Biosensing: Affinity Sensors | 1 |
| BIOM 527F/ ECE 527F | Biosensing: Biophotonic Sensors Using Refractive Index | 1 |
| BIOM 531/MECH 531 | Materials Engineering | 3 |
| BIOM 533/CIVE 533 | Biomolecular Tools for Engineers | 3 |
| BIOM 537/ECE 537 | Biomedical Signal Processing | 3 |
| BIOM 559/ECE 559 | Machine Learning in Imaging and Spectroscopy | 3 |
| BIOM 570/MECH 570 | Bioengineering | 3 |
| BIOM 572/MECH 572 | Regenerative Bioengineering with Stem Cells | 3 |
| BIOM 573/MECH 573 | Structure and Function of Biomaterials | 3 |
| BIOM 574/MECH 574 | Bio-Inspired Surfaces | 3 |
| BIOM 576/MECH 576 | Quantitative Systems Physiology | 4 |
| BIOM 578/MECH 578 | Musculoskeletal Biosolid Mechanics | 3 |
| BIOM 579/MECH 579 | Cardiovascular Biomechanics | 3 |
| BMS 301 | Human Gross Anatomy | 5 |
| BMS 302 | Laboratory in Principles of Physiology | 2 |
| BMS 310 | Anatomy for the Health Professions | 4 |
| BMS 320 | Virtual Laboratory in Physiology | 2 |
| BMS 325 | Cellular Neurobiology | 3 |
| BMS 345 | Functional Neuroanatomy | 4 |
| BMS 405 | Nerve and Muscle-Toxins, Trauma and Disease | 3 |
| BMS 409 | Human and Animal Reproductive Biology | 3 |
| BMS 420 | Cardiopulmonary Physiology | 3 |
| BMS 430 | Endocrinology | 3 |
| BMS 450 | Pharmacology | 3 |
| BMS 500 | Mammalian Physiology I | 4 |
| BMS 501 | Mammalian Physiology II | 4 |
| BMS 503/NB 503 | Developmental Neurobiology | 3 |
| BMS 505/NB 505 | Neuronal Circuits, Systems and Behavior | 3 |
| BZ 310 | Cell Biology | 4 |
| BZ 311 | Developmental Biology | 4 |
| BZ 350 | Molecular and General Genetics | 4 |
| BZ 476/BZ 576 | Genetics of Model Organisms | 3 |
| CBE 505 | Biochemical Engineering Laboratory | 1 |
| CBE 543 | Membranes for Biotechnology and Biomedicine | 3 |
| CHEM 334 | Quantitative Analysis Laboratory | 1 |
| CHEM 335 | Introduction to Analytical Chemistry | 3 |
| CHEM 433 | Clinical Chemistry | 3 |
| CHEM 539A | Principles of NMR and MRI: Basic NMR Principles | 1 |
| CHEM 539B | Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI | 1 |
| CHEM 539C | Principles of NMR and MRI: Advanced NMR and MRI Techniques | 1 |
| ECE 569/MECH 569 | Micro-Electro-Mechanical Devices | 3 |
| ENGR 533 | Spaceflight and Biological Systems | 3 |
| ERHS 332 | Principles of Epidemiology | 3 |
| ERHS 450 | Introduction to Radiation Biology | 3 |
| ERHS 502 | Fundamentals of Toxicology | 3 |
| ERHS 510/VS 510 | Cancer Biology | 3 |
| ERHS 540 | Principles of Ergonomics | 3 |
| FSHN 470 | Advanced Human Nutrition and Metabolism | 3 |
| HES 307 | Biomechanical Principles of Human Movement | 3 |
| HES 319 | Neuromuscular Aspects of Human Movement | 4 |
| HES 403 | Physiology of Exercise | 3 |
| HES 420 | Electrocardiography and Exercise Management | 3 |
| HES 476 | Exercise and Chronic Disease | 3 |
| MATH 455 | Mathematics in Biology and Medicine | 3 |
| MECH 543 | Biofluid Mechanics | 3 |
| MIP 300 | General Microbiology | 3 |
| MIP 302 | General 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 443 | Microbial Physiology | 3 |
| MIP 450 | Microbial Genetics | 3 |
| NB 500/BMS 502 | Readings in Cellular Neurobiology | 1 |

## CBE Technical Electives - Select 5 Credits

Select a minimum of 5 credits from the following or select additional credits from the Chemistry Electives list below.

| Code | Title | Credits |
|---|---|---|
| AB 410 | Understanding Pesticides | 3 |
| ATS 555 | Air Pollution | 3 |
| ATS 560 | Air Pollution Measurement | 2 |
| BC 401 | Comprehensive Biochemistry I | 3 |
| BC 403 | Comprehensive Biochemistry II | 3 |
| BC 404 | Comprehensive Biochemistry Laboratory | 2 |
| BC 406A | Investigative Biochemistry: Protein Biochemistry | 2 |

| | | |
|---|---|---|
| BC 406B | Investigative Biochemistry: Molecular Genetics | 2 |
| BC 406C | Investigative Biochemistry: Cellular Biochemistry | 2 |
| BC 411 | Physical Biochemistry | 4 |
| BC 441 | 3D Molecular Models for Biochemistry | 1 |
| BC 463 | Molecular Genetics | 3 |
| BC 464 | Molecular Genetics Recitation | 1 |
| BC 465 | Molecular Regulation of Cell Function | 3 |
| BC 517 | Metabolism | 2 |
| BC 521/CHEM 521 | Principles of Chemical Biology | 3 |
| BIOM 350A | Study Abroad--Ecuador: Prosthetics | 1-3 |
| BIOM 350B | Study Abroad--Portugal: Biomedical Engineering and Healthcare | 1 |
| BIOM 441 | Biomechanics and Biomaterials | 3 |
| BIOM 517/ECE 517 | Advanced Optical Imaging | 3 |
| BIOM 525/MECH 525 | Cell and Tissue Engineering | 3 |
| BIOM 526/ECE 526 | Biological Physics | 3 |
| BIOM 531/MECH 531 | Materials Engineering | 3 |
| BIOM 532/MECH 532 | Materials Issues in Mechanical Design | 3 |
| BIOM 533/CIVE 533 | Biomolecular Tools for Engineers | 3 |
| BIOM 537/ECE 537 | Biomedical Signal Processing | 3 |
| BIOM 573/MECH 573 | Structure and Function of Biomaterials | 3 |
| BIOM 574/MECH 574 | Bio-Inspired Surfaces | 3 |
| BIOM 576/MECH 576 | Quantitative Systems Physiology | 4 |
| BIOM 579/MECH 579 | Cardiovascular Biomechanics | 3 |
| BMS 301 | Human Gross Anatomy | 5 |
| BMS 302 | Laboratory in Principles of Physiology | 2 |
| BMS 305 | Domestic Animal Gross Anatomy | 4 |
| BMS 325 | Cellular Neurobiology | 3 |
| BMS 330 | Microscopic Anatomy | 4 |
| BMS 345 | Functional Neuroanatomy | 4 |
| BMS 409 | Human and Animal Reproductive Biology | 3 |
| BMS 420 | Cardiopulmonary Physiology | 3 |
| BMS 430 | Endocrinology | 3 |
| BMS 450 | Pharmacology | 3 |
| BMS 460 | Essentials of Pathophysiology | 3 |
| BMS 500 | Mammalian Physiology I | 4 |
| BMS 501 | Mammalian Physiology II | 4 |
| BMS 503/NB 503 | Developmental Neurobiology | 3 |
| BMS 505/NB 505 | Neuronal Circuits, Systems and Behavior | 3 |
| BMS 545 | Neuroanatomy | 5 |
| BMS 575 | Human Anatomy Dissection | 4 |
| BSPM 302 | Applied and General Entomology | 2 |
| BSPM 361 | Elements of Plant Pathology | 3 |
| BZ 240 | Synthetic Biology-Principles and Applications | 3 |
| BZ 310 | Cell Biology | 4 |
| BZ 311 | Developmental Biology | 4 |
| BZ 348/MATH 348 | Theory of Population and Evolutionary Ecology | 4 |
| BZ 350 | Molecular and General Genetics | 4 |
| BZ 360 | Bioinformatics and Genomics | 4 |
| CBE 406 | Introduction to Transport Phenomena | 3 |
| CBE 501 | Chemical Engineering Thermodynamics | 3 |
| CBE 502 | Advanced Reactor Design | 3 |
| CBE 503 | Transport Phenomena Fundamentals | 3 |
| CBE 504/BIOM 504 | Fundamentals of Biochemical Engineering | 3 |
| CBE 505 | Biochemical Engineering Laboratory | 1 |
| CBE 514 | Polymer Science and Engineering | 3 |
| CBE 521 | Mathematical Modeling for Chemical Engineers | 3 |
| CBE 522/BIOM 522 | Bioseparation Processes | 3 |
| CBE 524 | Bioremediation | 1 |
| CBE 540/CIVE 540 | Advanced Biological Wastewater Processing | 3 |
| CBE 560 | Engineering of Protein Expression Systems | 3 |
| CBE 570 | Biomolecular Engineering/Synthetic Biology | 3 |
| CIVE 322 | Basic Hydrology | 3 |
| CIVE 330 | Ecological Engineering | 3 |
| CIVE 360 | Mechanics of Solids | 3 |
| CIVE 371 | Study Abroad--Peru: Grand Challenges in Engineering in Peru | 3 |
| CIVE 401 | Hydraulic Engineering | 3 |
| CIVE 423 | Groundwater Engineering | 3 |
| CIVE 438 | Fundamentals of Environmental Engr | 3 |
| CIVE 439 | Applications of Environmental Engr Concepts | 3 |
| CIVE 440 | Nonpoint Source Pollution | 3 |
| CIVE 442 | Air Quality Engineering | 3 |
| CIVE 515 | River Mechanics | 3 |
| CIVE 520 | Physical Hydrology | 3 |
| CIVE 531 | Groundwater Hydrology | 3 |
| CIVE 538 | Aqueous Chemistry | 3 |
| CIVE 560 | Advanced Mechanics of Materials | 3 |
| CS 165 | CS2--Data Structures | 4 |
| CS 220 | Discrete Structures and the Applications | 4 |
| CS 270 | Computer Organization | 4 |
| ECE 204 | Introduction to Electrical Engineering | 3 |
| ECE 430/MATH 430 | Fourier and Wavelet Analysis with Apps | 3 |
| ECE 527A/ BIOM 527A | Biosensing: Cells as Circuits | 1 |
| ECE 527B/ BIOM 527B | Biosensing: Signal and Noise in Biosensors | 1 |
| ECE 527C/ BIOM 527C | Biosensing: Sensor Circuit Fundamentals | 1 |
| ECE 527D/ BIOM 527D | Biosensing: Electrochemical Sensors | 1 |
| ECE 527E/ BIOM 527E | Biosensing: Affinity Sensors | 1 |
| ECE 527F/ BIOM 527F | Biosensing: Biophotonic Sensors Using Refractive Index | 1 |
| ENGR 478 | Applied Engineering Data Analytics | 3 |
| ENGR 510 | Engineering Optimization: Method/ Application | 3 |

| | | |
|---|---|---|
| ENGR 550/ MATH 550 | Numerical Methods in Science and Engineering | 3 |
| ERHS 320 | Environmental Health--Water Quality | 3 |
| ERHS 332 | Principles of Epidemiology | 3 |
| ERHS 410 | Environmental Health-Air and Waste Management | 3 |
| ERHS 446 | Environmental Toxicology | 3 |
| ERHS 448 | Environmental Contaminants | 3 |
| ERHS 450 | Introduction to Radiation Biology | 3 |
| ERHS 502 | Fundamentals of Toxicology | 3 |
| ERHS 503 | Toxicology Principles | 1 |
| ERHS 510/VS 510 | Cancer Biology | 3 |
| ERHS 530 | Radiological Physics and Dosimetry I | 3 |
| ERHS 542 | Biostatistical Methods for Qualitative Data | 3 |
| ERHS 547 | Equipment and Instrumentation | 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 |
| F 311 | Forest Ecology | 3 |
| FTEC 447 | Food Chemistry | 3 |
| GEOL 150 | Dynamic Earth (GT-SC2) | 4 |
| GEOL 452 | Hydrogeology | 4 |
| GEOL 454 | Geomorphology | 4 |
| 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 |
| HES 307 | Biomechanical Principles of Human Movement | 3 |
| HES 319 | Neuromuscular Aspects of Human Movement | 4 |
| HES 403 | Physiology of Exercise | 3 |
| 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 II | 3 |
| MECH 324 | Dynamics of Machines | 4 |
| MECH 325 | Machine Design with Finite Element Analysis | 4 |
| 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 436/MSE 436 | Green Engineering--Materials and Environment | 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 516 | Life Cycle and Techno-Economic Assessment | 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 410 | Foundations of Modern Biotechnology | 2 |
| 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 | 3 |
| 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 |
| MSE 501 | Materials Technology Transfer | 1 |
| MSE 502A | Materials Science and Engineering Methods: Materials Structure and Scattering | 1 |
| MSE 502B | Materials Science and Engineering Methods: Computational Materials Methods | 1 |
| MSE 502C | Materials Science and Engineering Methods: Materials Microscopy | 1 |
| MSE 502D | Materials Science and Engineering Methods: Materials Spectroscopy | 1 |
| MSE 502E | Materials Science and Engineering Methods: Bulk Properties and Performance | 1 |
| MSE 502F | Materials Science and Engineering Methods: Experimental Methods for Materials Research | 1 |
| MSE 503 | Mechanical Behavior of Materials | 3 |
| MSE 504 | Thermodynamics of Materials | 3 |
| MSE 505 | Kinetics of Materials | 3 |
| NR 319 | Introduction to Geospatial Science | 4 |
| NR 323/GR 323 | Remote Sensing and Image Interpretation | 3 |
| NR 505 | Concepts in GIS | 4 |
| PH 314 | Introduction to Modern Physics | 4 |
| PH 315 | Modern Physics Laboratory | 2 |
| PH 341 | Mechanics | 4 |
| PH 351 | Electricity and Magnetism | 4 |
| PH 353 | Optics and Waves | 4 |
| PH 361 | Physical Thermodynamics | 3 |
| PH 451 | Introductory Quantum Mechanics I | 3 |
| PH 452 | Introductory Quantum Mechanics II | 3 |
| PH 517 | Chaos, Fractals, and Nonlinear Dynamics | 3 |
| PH 521 | Introduction to Lasers | 3 |
| PH 522 | Introductory Laser Laboratory | 1 |
| PH 531 | Introductory Condensed Matter Physics | 3 |
| PH 561 | Elementary Particle Physics | 3 |
| PH 571 | Mathematical Methods for Physics I | 3 |
| PHIL 410 | Gödel's Incompleteness Theorems | 3 |
| SOCR 322 | Principles of Microclimatology | 3 |
| SOCR 330 | Principles of Genetics | 3 |
| SOCR 375 | Soil Biogeochemistry | 3 |
| SOCR 400 | Soils and Global Change-Impacts and Solutions | 3 |
| SOCR 455 | Microbiomes of Soil Systems | 3 |
| SOCR 456 | Soil Microbiology Laboratory | 1 |
| SOCR 467 | Soil and Environmental Chemistry | 3 |
| SOCR 470 | Soil Physics | 3 |
| SOCR 471 | Soil Physics Laboratory | 1 |
| SOCR 567 | Environmental Soil Chemistry | 4 |
| STAR 512 | Design and Data Analysis for Researchers II | 4 |
| STAT 305 | Sampling Techniques | 3 |
| STAT 307 | Introduction to Biostatistics | 3 |
| STAT 341 | Statistical Data Analysis I | 3 |
| STAT 342 | Statistical Data Analysis II | 3 |
| STAT 400 | Statistical Computing | 3 |
| STAT 420 | Probability and Mathematical Statistics I | 3 |
| STAT 421 | Introduction to Stochastic Processes | 3 |
| STAT 430 | Probability and Mathematical Statistics II | 3 |
| STAT 460 | Applied Multivariate Analysis | 3 |
| SYSE 530 | Overview of Systems Engineering Processes | 3 |
| SYSE 532/ECE 532 | Dynamics of Complex Engineering Systems | 3 |

A maximum of 3 credits may be selected from the following courses:

| | |
|---|---|
| ENGR 422 | Technology Entrepreneurship |
| ENGR 502 | Engineering Project and Program Management |
| ENGR 525 | Intellectual Property and Invention Systems |
| FIN 305 | Fundamentals of Finance |
| IDEA 310B | Design Thinking Toolbox: 3D Modeling |
| IDEA 310D | Design Thinking Toolbox: Digital Imaging |
| MGT 305 | Fundamentals of Management |
| MGT 340 | Fundamentals of Entrepreneurship |
| MKT 305 | Fundamentals of Marketing |

## Chemistry Electives - Select 6 Credits

| Code | Title | Credits |
|---|---|---|
| BC 400-479 | | |
| BC 500-579 | | |
| CBE 310 | Molecular Concepts and Applications | 3 |
| CHEM 231 | Foundations of Analytical Chemistry | 3 |
| CHEM 232 | Foundations of Analytical Chemistry Lab | 2 |
| CHEM 261 | Fundamentals of Inorganic Chemistry | 3 |
| CHEM 263 | Foundations of Inorganic Chemistry | 4 |
| CHEM 264 | Foundations of Inorganic Chemistry Laboratory | 1 |
| CHEM 310-340 | | |
| CHEM 350-379 | | |
| CHEM 400-479 | | |
| CHEM 500-579 | | |

## BME Broad Electives – Select 3 credits

| Code | Title | Credits |
|---|---|---|
| AB 410 | Understanding Pesticides | 3 |
| ART 231 | Photo Image Making for Non-Art Majors | 3 |
| ATS 550 | Atmospheric Radiation and Remote Sensing | 3 |
| ATS 555 | Air Pollution | 3 |
| ATS 560 | Air Pollution Measurement | 2 |
| BC 401 | Comprehensive Biochemistry I | 3 |
| BC 403 | Comprehensive Biochemistry II | 3 |
| BC 404 | Comprehensive Biochemistry Laboratory | 2 |
| BC 406A | Investigative Biochemistry: Protein Biochemistry | 2 |
| BC 406B | Investigative Biochemistry: Molecular Genetics | 2 |
| BC 406C | Investigative Biochemistry: Cellular Biochemistry | 2 |
| BC 411 | Physical Biochemistry | 4 |
| BC 441 | 3D Molecular Models for Biochemistry | 1 |
| BC 463 | Molecular Genetics | 3 |
| BC 464 | Molecular Genetics Recitation | 1 |
| BC 465 | Molecular Regulation of Cell Function | 3 |
| BC 517 | Metabolism | 2 |
| BC 521/CHEM 521 | Principles of Chemical Biology | 3 |
| BC 563 | Molecular Genetics | 4 |
| BIOM 304 | Global Challenges and Collaborations in BME | 3 |
| BIOM 350A | Study Abroad--Ecuador: Prosthetics | 1-3 |
| BIOM 350B | Study Abroad--Portugal: Biomedical Engineering and Healthcare | 1 |
| BIOM 431/ECE 431 | Biomedical Signal and Image Processing | 3 |
| BIOM 441 | Biomechanics and Biomaterials | 3 |
| BIOM 504/CBE 504 | Fundamentals of Biochemical Engineering | 3 |
| BIOM 517/ECE 517 | Advanced Optical Imaging | 3 |
| BIOM 518/ECE 518 | Biophotonics | 3 |
| BIOM 522/CBE 522 | Bioseparation Processes | 3 |
| BIOM 525/MECH 525 | Cell and Tissue Engineering | 3 |
| BIOM 526/ECE 526 | Biological Physics | 3 |
| BIOM 527A/ ECE 527A | Biosensing: Cells as Circuits | 1 |
| BIOM 527B/ ECE 527B | Biosensing: Signal and Noise in Biosensors | 1 |
| BIOM 527C/ ECE 527C | Biosensing: Sensor Circuit Fundamentals | 1 |
| BIOM 527D/ ECE 527D | Biosensing: Electrochemical Sensors | 1 |
| BIOM 527E/ ECE 527E | Biosensing: Affinity Sensors | 1 |
| BIOM 527F/ ECE 527F | Biosensing: Biophotonic Sensors Using Refractive Index | 1 |
| BIOM 531/MECH 531 | Materials Engineering | 3 |
| BIOM 532/MECH 532 | Materials Issues in Mechanical Design | 3 |
| BIOM 533/CIVE 533 | Biomolecular Tools for Engineers | 3 |
| BIOM 537/ECE 537 | Biomedical Signal Processing | 3 |
| BIOM 559/ECE 559 | Machine Learning in Imaging and Spectroscopy | 3 |
| BIOM 570/MECH 570 | Bioengineering | 3 |
| BIOM 572/MECH 572 | Regenerative Bioengineering with Stem Cells | 3 |
| BIOM 573/MECH 573 | Structure and Function of Biomaterials | 3 |
| BIOM 574/MECH 574 | Bio-Inspired Surfaces | 3 |
| BIOM 576/MECH 576 | Quantitative Systems Physiology | 4 |
| BIOM 578/MECH 578 | Musculoskeletal Biosolid Mechanics | 3 |
| BIOM 579/MECH 579 | Cardiovascular Biomechanics | 3 |
| BMS 301 | Human Gross Anatomy | 5 |
| BMS 302 | Laboratory in Principles of Physiology | 2 |
| BMS 305 | Domestic Animal Gross Anatomy | 4 |
| BMS 310 | Anatomy for the Health Professions | 4 |
| BMS 320 | Virtual Laboratory in Physiology | 2 |
| BMS 325 | Cellular Neurobiology | 3 |
| BMS 330 | Microscopic Anatomy | 4 |
| BMS 345 | Functional Neuroanatomy | 4 |
| BMS 405 | Nerve and Muscle-Toxins, Trauma and Disease | 3 |
| BMS 409 | Human and Animal Reproductive Biology | 3 |
| BMS 420 | Cardiopulmonary Physiology | 3 |
| BMS 430 | Endocrinology | 3 |
| BMS 450 | Pharmacology | 3 |
| BMS 460 | Essentials of Pathophysiology | 3 |
| BMS 500 | Mammalian Physiology I | 4 |
| BMS 501 | Mammalian Physiology II | 4 |
| BMS 503/NB 503 | Developmental Neurobiology | 3 |
| BMS 505/NB 505 | Neuronal Circuits, Systems and Behavior | 3 |
| BMS 545 | Neuroanatomy | 5 |
| BMS 575 | Human Anatomy Dissection | 4 |
| BSPM 302 | Applied and General Entomology | 2 |
| BSPM 361 | Elements of Plant Pathology | 3 |
| BZ 240 | Synthetic Biology-Principles and Applications | 3 |
| BZ 310 | Cell Biology | 4 |
| BZ 311 | Developmental Biology | 4 |
| BZ 348/MATH 348 | Theory of Population and Evolutionary Ecology | 4 |
| BZ 350 | Molecular and General Genetics | 4 |
| BZ 360 | Bioinformatics and Genomics | 4 |
| BZ 420 | Evolutionary Medicine | 3 |
| BZ 476/BZ 576 | Genetics of Model Organisms | 3 |
| CBE 406 | Introduction to Transport Phenomena | 3 |
| CBE 501 | Chemical Engineering Thermodynamics | 3 |
| CBE 502 | Advanced Reactor Design | 3 |
| CBE 503 | Transport Phenomena Fundamentals | 3 |
| CBE 505 | Biochemical Engineering Laboratory | 1 |
| CBE 514 | Polymer Science and Engineering | 3 |
| CBE 521 | Mathematical Modeling for Chemical Engineers | 3 |
| CBE 524 | Bioremediation | 1 |

| | | |
|---|---|---|
| CBE 540/CIVE 540 | Advanced Biological Wastewater Processing | 3 |
| CBE 560 | Engineering of Protein Expression Systems | 3 |
| CBE 570 | Biomolecular Engineering/Synthetic Biology | 3 |
| CHEM 231 | Foundations of Analytical Chemistry | 3 |
| CHEM 232 | Foundations of Analytical Chemistry Lab | 2 |
| CHEM 261 | Fundamentals of Inorganic Chemistry | 3 |
| CHEM 263 | Foundations of Inorganic Chemistry | 4 |
| CHEM 264 | Foundations of Inorganic Chemistry Laboratory | 1 |
| CHEM 311 | Introduction to Nanoscale Science | 3 |
| CHEM 315 | Foundations of Polymer Chemistry | 3 |
| CHEM 320 | Chemistry of Addictions | 3 |
| CHEM 333 | Forensic Chemistry | 3 |
| CHEM 334 | Quantitative Analysis Laboratory | 1 |
| CHEM 335 | Introduction to Analytical Chemistry | 3 |
| CHEM 338 | Environmental Chemistry | 3 |
| CHEM 355 | Foundations of Sustainable Chemistry | 3 |
| CHEM 431 | Instrumental Analysis | 4 |
| CHEM 433 | Clinical Chemistry | 3 |
| CHEM 440 | Advanced Organic Chemistry Laboratory | 2 |
| CHEM 445 | Synthetic Organic Chemistry | 3 |
| CHEM 448 | Medicinal Chemistry | 3 |
| CHEM 451 | Foundations of Catalytic Chemistry | 3 |
| CHEM 461 | Inorganic Chemistry | 3 |
| CHEM 462 | Inorganic Chemistry Laboratory | 2 |
| CHEM 465 | Chemistry of Sustainable E-Waste Management | 1 |
| CHEM 522 | Methods of Chemical Biology | 2 |
| CHEM 532 | Advanced Chemical Analysis II | 3 |
| CHEM 537 | Electrochemical Methods | 3 |
| CHEM 539A | Principles of NMR and MRI: Basic NMR Principles | 1 |
| CHEM 539B | Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI | 1 |
| CHEM 539C | Principles of NMR and MRI: Advanced NMR and MRI Techniques | 1 |
| CHEM 541 | Organic Molecular Structure Determination | 2 |
| CHEM 543 | Structure/Mechanisms in Organic Chemistry | 2 |
| CHEM 545 | Synthetic Organic Chemistry I | 3 |
| CHEM 547 | Physical Organic Chemistry | 3 |
| CHEM 555 | Chemistry of Sustainability | 3 |
| CHEM 560 | Foundations of Inorganic Synthesis | 1 |
| CHEM 566 | Bioinorganic Chemistry | 3 |
| CHEM 567 | Crystallographic Computation | 1 |
| CHEM 569 | Chemical Crystallography | 3 |
| CHEM 570 | Chemical Bonding | 3 |
| CHEM 575 | Fundamentals of Chemical Thermodynamics | 1 |
| CHEM 576 | Statistical Mechanics | 2 |
| CHEM 577 | Surface Chemistry | 3 |
| CHEM 578A | Computational Chemistry: Electronic Structure | 1 |
| CHEM 579 | Chemical Kinetics | 3 |
| CIVE 322 | Basic Hydrology | 3 |
| CIVE 330 | Ecological Engineering | 3 |
| CIVE 360 | Mechanics of Solids | 3 |
| CIVE 367 | Structural Analysis | 3 |
| CIVE 371 | Study Abroad--Peru: Grand Challenges in Engineering in Peru | 3 |
| CIVE 401 | Hydraulic Engineering | 3 |
| CIVE 423 | Groundwater Engineering | 3 |
| CIVE 438 | Fundamentals of Environmental Engr | 3 |
| CIVE 439 | Applications of Environmental Engr Concepts | 3 |
| CIVE 440 | Nonpoint Source Pollution | 3 |
| CIVE 442 | Air Quality Engineering | 3 |
| CIVE 515 | River Mechanics | 3 |
| CIVE 520 | Physical Hydrology | 3 |
| CIVE 524/WR 524 | Modeling Watershed Hydrology | 3 |
| CIVE 531 | Groundwater Hydrology | 3 |
| CIVE 538 | Aqueous Chemistry | 3 |
| CIVE 560 | Advanced Mechanics of Materials | 3 |
| CIVE 562 | Fundamentals of Vibrations | 3 |
| CS 152 | Python for STEM | 2 |
| CS 164 | CS1--Computational Thinking with Java | 4 |
| CS 165 | CS2--Data Structures | 4 |
| CS 220 | Discrete Structures and the Applications | 4 |
| CS 253 | Software Development with C++ | 4 |
| CS 270 | Computer Organization | 4 |
| CS 314 | Software Engineering | 3 |
| CS 320 | Algorithms--Theory and Practice | 3 |
| CS 356 | Systems Security | 3 |
| CS 370 | Operating Systems | 3 |
| CS 4** - Any 400-level CS course except CS 495 | | |
| CS 5** - Any 500-level CS course | | |
| DSCI 320/MATH 320 | Optimization Methods in Data Science | 3 |
| DSCI 369 | Linear Algebra for Data Science | 3-4 |
| or MATH 369 | Linear Algebra I | |
| ECE 204 | Introduction to Electrical Engineering | 3 |
| ECE 312 | Linear System Analysis II | 3 |
| ECE 4** - any ECE course at the 400-level except ECE 495 | | |
| ECE 5** - any ECE course at the 500-level | | |
| ENGR 300 | 3D Printing Lab for Engineers | 1 |
| ENGR 422 | Technology Entrepreneurship | 3 |
| ENGR 478 | Applied Engineering Data Analytics | 3 |
| ENGR 502 | Engineering Project and Program Management | 3 |
| ENGR 510 | Engineering Optimization: Method/ Application | 3 |
| ENGR 525 | Intellectual Property and Invention Systems | 3 |
| ENGR 531 | Engineering Risk Analysis | 3 |
| ENGR 533 | Spaceflight and Biological Systems | 3 |

| | | |
|---|---|---|
| ENGR 550/ MATH 550 | Numerical Methods in Science and Engineering | 3 |
| ENGR 570 | Coupled Electromechanical Systems | 3 |
| ERHS 320 | Environmental Health--Water Quality | 3 |
| ERHS 332 | Principles of Epidemiology | 3 |
| ERHS 400 | Radiation Safety | 3 |
| ERHS 410 | Environmental Health-Air and Waste Management | 3 |
| ERHS 430 | Human Disease and the Environment | 3 |
| ERHS 446 | Environmental Toxicology | 3 |
| ERHS 448 | Environmental Contaminants | 3 |
| ERHS 450 | Introduction to Radiation Biology | 3 |
| ERHS 502 | Fundamentals of Toxicology | 3 |
| ERHS 503 | Toxicology Principles | 1 |
| ERHS 510/VS 510 | Cancer Biology | 3 |
| ERHS 530 | Radiological Physics and Dosimetry I | 3 |
| ERHS 540 | Principles of Ergonomics | 3 |
| ERHS 542 | Biostatistical Methods for Qualitative Data | 3 |
| ERHS 547 | Equipment and Instrumentation | 3 |
| ERHS 560 | Health Impact Assessment | 2 |
| ESS 311 | Ecosystem Ecology | 3 |
| ESS 312 | Sustainability Science | 3 |
| ESS 330 | Quantitative Reasoning for Ecosystem Science | 3 |
| ESS 353 | Global Change Impacts, Adaptation, Mitigation | 3 |
| ESS 440 | Practicing Sustainability | 4 |
| ESS 501 | Principles of Ecosystem Sustainability | 3 |
| ESS 524 | Foundations for Carbon/Greenhouse Gas Mgmt | 3 |
| F 311 | Forest Ecology | 3 |
| FIN 305 | Fundamentals of Finance | 3 |
| FSHN 470 | Advanced Human Nutrition and Metabolism | 3 |
| FTEC 447 | Food Chemistry | 3 |
| GEOL 150 | Dynamic Earth (GT-SC2) | 4 |
| GEOL 452 | Hydrogeology | 4 |
| GEOL 454 | Geomorphology | 4 |
| GES 362 | Systems Thinking and Sustainability | 3 |
| GES 441 | Analysis of Sustainable Energy Solutions | 3 |
| GES 450 | Global Sustainability and Health | 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 |
| GR 305 | Geography of Global Health | 3 |
| HES 207 | Anatomical Kinesiology | 4 |
| HES 307 | Biomechanical Principles of Human Movement | 3 |
| HES 319 | Neuromuscular Aspects of Human Movement | 4 |
| HES 345 | Population Health and Disease Prevention | 3 |
| HES 403 | Physiology of Exercise | 3 |
| HES 420 | Electrocardiography and Exercise Management | 3 |
| HES 476 | Exercise and Chronic Disease | 3 |
| HORT 579 | Mass Spectrometry Omics-Methods and Analysis | 3 |
| IDEA 310B | Design Thinking Toolbox: 3D Modeling | 3 |
| IDEA 310D | Design Thinking Toolbox: Digital Imaging | 1 |
| IDEA 310H/CS 310H | Design Thinking Toolbox: Mixed Reality Design | 3 |
| IDEA 455/MGT 455 | Designing for Defense | 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 |
| LSPA 340 | Spanish for Animal Health and Care Fields | 3 |
| LSPA 346 | Spanish for Health Care | 3 |
| MATH 229 | Matrices and Linear Equations | 2 |
| MATH 235 | Introduction to Mathematical Reasoning | 2 |
| MATH 301 | Introduction to Combinatorial Theory | 3 |
| MATH 317 | Advanced Calculus of One Variable | 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 405 | Introduction to Number Theory | 3 |
| MATH 417 | Advanced Calculus I | 3 |
| MATH 418 | Advanced Calculus II | 3 |
| MATH 419 | Introduction to Complex Variables | 3 |
| MATH 430/ECE 430 | Fourier and Wavelet Analysis with Apps | 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 463 | Post-Quantum Cryptography | 3 |
| MATH 466 | Abstract Algebra I | 3 |
| MATH 467 | Abstract Algebra II | 3 |
| MATH 469 | Linear Algebra II | 3 |
| MATH 470 | Euclidean and Non-Euclidean Geometry | 3 |
| MATH 474 | Introduction to Differential Geometry | 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 |
| MATH 569A/ DSCI 569A | Linear Algebra for Data Science: Matrices and Vectors Spaces | 1 |
| MATH 569B/ DSCI 569B | Linear Algebra for Data Science: Geometric Techniques for Data Reduction | 1 |

| | | |
|---|---|---|
| MATH 569C/ DSCI 569C | Linear Algebra for Data Science: Matrix Factorizations and Transformations | 1 |
| MATH 569D/ DSCI 569D | Linear Algebra for Data Science: Theoretical Foundations | 1 |
| MECH 200 | Introduction to Manufacturing Processes | 3 |
| MECH 307 | Mechatronics II | 3 |
| MECH 324 | Dynamics of Machines | 4 |
| MECH 325 | Machine Design with Finite Element Analysis | 4 |
| MECH 331 | Introduction to Engineering Materials | 4 |
| MECH 4** - Any 400-level MECH course except MECH 495 | | |
| MECH 5** - Any 500-level MECH course | | |
| MGT 305 | Fundamentals of Management | 3 |
| MGT 340 | Fundamentals of Entrepreneurship | 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 410 | Foundations of Modern Biotechnology | 2 |
| 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 | 3 |
| 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 |
| MKT 305 | Fundamentals of Marketing | 3 |
| MSE 501 | Materials Technology Transfer | 1 |
| MSE 502A | Materials Science and Engineering Methods: Materials Structure and Scattering | 1 |
| MSE 502B | Materials Science and Engineering Methods: Computational Materials Methods | 1 |
| MSE 502C | Materials Science and Engineering Methods: Materials Microscopy | 1 |
| MSE 502D | Materials Science and Engineering Methods: Materials Spectroscopy | 1 |
| MSE 502E | Materials Science and Engineering Methods: Bulk Properties and Performance | 1 |
| MSE 502F | Materials Science and Engineering Methods: Experimental Methods for Materials Research | 1 |
| MSE 503 | Mechanical Behavior of Materials | 3 |
| MSE 504 | Thermodynamics of Materials | 3 |
| MSE 505 | Kinetics of Materials | 3 |
| NR 319 | Introduction to Geospatial Science | 4 |
| NR 323/GR 323 | Remote Sensing and Image Interpretation | 3 |
| NR 505 | Concepts in GIS | 4 |
| PH 314 | Introduction to Modern Physics | 4 |
| PH 315 | Modern Physics Laboratory | 2 |
| PH 341 | Mechanics | 4 |
| PH 351 | Electricity and Magnetism | 4 |
| PH 353 | Optics and Waves | 4 |
| PH 361 | Physical Thermodynamics | 3 |
| PH 425 | Advanced Physics Laboratory | 2 |
| PH 451 | Introductory Quantum Mechanics I | 3 |
| PH 452 | Introductory Quantum Mechanics II | 3 |
| PH 462 | Statistical Physics | 3 |
| PH 517 | Chaos, Fractals, and Nonlinear Dynamics | 3 |
| PH 521 | Introduction to Lasers | 3 |
| PH 522 | Introductory Laser Laboratory | 1 |
| PH 531 | Introductory Condensed Matter Physics | 3 |
| PH 561 | Elementary Particle Physics | 3 |
| PH 571 | Mathematical Methods for Physics I | 3 |
| PHIL 322 | Biomedical Ethics | 3 |
| PHIL 410 | Gödel's Incompleteness Theorems | 3 |
| PSY 253 | Human Factors and Engineering Psychology | 3 |
| SOCR 322 | Principles of Microclimatology | 3 |
| SOCR 330 | Principles of Genetics | 3 |
| SOCR 375 | Soil Biogeochemistry | 3 |
| SOCR 400 | Soils and Global Change-Impacts and Solutions | 3 |
| SOCR 455 | Microbiomes of Soil Systems | 3 |
| SOCR 456 | Soil Microbiology Laboratory | 1 |
| SOCR 467 | Soil and Environmental Chemistry | 3 |
| SOCR 470 | Soil Physics | 3 |
| SOCR 471 | Soil Physics Laboratory | 1 |
| SOCR 567 | Environmental Soil Chemistry | 4 |
| SPCM 434 | International and Intercultural Communication | 3 |
| STAR 512 | Design and Data Analysis for Researchers II | 4 |
| STAT 158 | Introduction to R Programming | 1 |
| STAT 305 | Sampling Techniques | 3 |
| STAT 307 | Introduction to Biostatistics | 3 |
| STAT 331 | Intermediate Applied Statistical Methods | 3 |
| STAT 341 | Statistical Data Analysis I | 3 |
| STAT 342 | Statistical Data Analysis II | 3 |
| STAT 400 | Statistical Computing | 3 |
| STAT 420 | Probability and Mathematical Statistics I | 3 |
| STAT 421 | Introduction to Stochastic Processes | 3 |
| STAT 430 | Probability and Mathematical Statistics II | 3 |
| STAT 460 | Applied Multivariate Analysis | 3 |
| SYSE 501 | Foundations of Systems Engineering | 3 |
| SYSE 505 | Systems Thinking for the Real World | 3 |

| | | |
|---|---|---|
| SYSE 530 | Overview of Systems Engineering Processes | 3 |
| SYSE 532/ECE 532 | Dynamics of Complex Engineering Systems | 3 |
| SYSE 534 | Human Systems Integration | 3 |
| VS 333 | Domestic Animal Anatomy | 4 |

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

***Freshman***

| **Semester 1** | | **Critical** | **Recommended** | **AUCC** | **Credits** |
|---|---|---|---|---|---|
| CHEM 120 | Foundations of Modern Chemistry (GT-SC2) | X | | 3A | 4 |
| CHEM 121 | Foundations of Modern Chemistry Laboratory (GT-SC1) | X | | 3A | 1 |
| CO 150 | College Composition (GT-CO2) | X | | 1A | 3 |
| MATH 160 | Calculus for Physical Scientists I (GT-MA1) | X | | 1B | 4 |
| Select one Group from the Following: | | | | | 3 |
| Group A: | | | | | |
| ENGR 111 | Fundamentals of Engineering | X | | | |
| Group B: | | | | | |
| CBE 101 | Introduction to Chemical and Biological Engr | X | | | |
| Group C: | | | | | |
| CBE 101A | Introduction to Chemical and Biological Engr: Lecture | X | | | |
| CBE 101B | Introduction to Chemical and Biological Engr: Laboratory | X | | | |
| CBE 160 | MATLAB for Chemical and Biological Eng | X | | | |
| Group D: | | | | | |
| CBE 104A | Study Abroad--Denmark: Intro to Chemical and Biological Engineering | X | | | |
| | **Total Credits** | | | | **15** |

| **Semester 2** | | **Critical** | **Recommended** | **AUCC** | **Credits** |
|---|---|---|---|---|---|
| ENGR 114 | Engineering for Grand Challenges | X | | | 3 |
| LIFE 102 | Attributes of Living Systems (GT-SC1) | X | | 3A | 4 |
| MATH 161 | Calculus for Physical Scientists II (GT-MA1) | X | | 1B | 4 |
| Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences) | | | X | 3C | 3 |
| | **Total Credits** | | | | **14** |

***Sophomore***

| **Semester 3** | | **Critical** | **Recommended** | **AUCC** | **Credits** |
|---|---|---|---|---|---|
| CBE 201 | Material and Energy Balances | X | | | 3 |
| CBE 205 | Fundamentals of Biological Engineering | X | | | 3 |
| MATH 261 | Calculus for Physical Scientists III | X | | | 4 |
| PH 141 | Physics for Scientists and Engineers I (GT-SC1) | X | | 3A | 5 |
| | **Total Credits** | | | | **15** |

| **Semester 4** | | **Critical** | **Recommended** | **AUCC** | **Credits** |
|---|---|---|---|---|---|
| CBE 210 | Thermodynamic Process Analysis | X | | | 3 |
| CBE 223 | CBE Design and Experimentation I | X | | | 2 |
| CHEM 241 | Foundations of Organic Chemistry | X | | | 4 |
| CHEM 242 | Foundations of Organic Chemistry Laboratory | X | | | 1 |
| CBE 393 | Professional Development Seminar | X | | | 1 |
| MATH 340 | Intro to Ordinary Differential Equations | X | | | 4 |
| | **Total Credits** | | | | **15** |

***Junior***

| Semester 5 | | Critical | Recommended | AUCC | Credits |
|---|---|---|---|---|---|
| CBE 320 | Chemical and Biological Reactor Design | X | | | 3 |
| CBE 330 | Process Simulation | X | | | 3 |
| CBE 331 | Momentum Transfer and Mechanical Separations | X | | | 3 |
| CBE 334 | CBE Design and Experimentation II | X | | | 1 |
| Select one of the following courses: | | | | | 4 |
| BC 351 | Principles of Biochemistry | | X | | |
| BMS 300 | Principles of Human Physiology | | X | | |
| Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities) | | | X | 3B | 3 |
| | **Total Credits** | | | | **17** |

| Semester 6 | | Critical | Recommended | AUCC | Credits |
|---|---|---|---|---|---|
| BIOM 300 | Problem-Based Learning Biomedical Engr Lab | X | | | 4 |
| CBE 332 | Heat and Mass Transfer Fundamentals | X | | | 3 |
| CBE 335 | CBE Design and Experimentation III | X | | | 1 |
| CBE 340 | Statistics for CBE Applications | X | | | 3 |
| MECH 262 | Engineering Mechanics | X | | | 4 |
| | **Total Credits** | | | | **15** |

***Senior***

| Semester 7 | | Critical | Recommended | AUCC | Credits |
|---|---|---|---|---|---|
| BIOM 422 | Quantitative Systems and Synthetic Biology | X | | | 3 |
| CBE 442 | Separation Processes | X | | | 4 |
| CBE 443 | Chemical and Biological Engineering Lab II | X | | | 2 |
| CBE 451 | Chemical and Biological Engineering Design I | X | | | 3 |
| BME Broad Elective (See List on Requirements Tab) | | | X | | 3 |
| Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives) | | | X | 3D | 3 |
| | **Total Credits** | | | | **18** |

| Semester 8 | | Critical | Recommended | AUCC | Credits |
|---|---|---|---|---|---|
| BIOM 421 | Transport Phenomena in Biomedical Engineering | | | | 3 |
| CBE 430 | Process Control and Instrumentation | X | | | 3 |
| PH 142 | Physics for Scientists and Engineers II (GT-SC1) | | X | 3A | 5 |
| Chemistry Elective (See List on Requirements Tab) | | | X | | 3 |
| Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing) | | | X | 2 | 3 |
| | **Total Credits** | | | | **17** |

***Fifth Year***

| Semester 9 | | Critical | Recommended | AUCC | Credits |
|---|---|---|---|---|---|
| BIOM 486A | Biomedical Design Practicum: Capstone Design I | X | | 4A,4B,4C | 4 |
| Select one of the following courses (one that you have not taken previously): | | X | | | 4 |
| BC 351 | Principles of Biochemistry | X | | | |
| BMS 300 | Principles of Human Physiology | X | | | |
| BME Technical Elective (See List on Requirements Tab) | | | X | | 3 |
| CBE Technical Elective (See List on Requirements Tab) | | | X | | 2 |
| 1C (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#aucc) | | | X | 1C | 3 |
| | **Total Credits** | | | | **16** |

| Semester 10 | | Critical | Recommended | AUCC | Credits |
|---|---|---|---|---|---|
| BIOM 486B | Biomedical Design Practicum: Capstone Design II | X | | 4A,4B,4C | 4 |
| BME Technical Elective (See List on Requirements Tab) | | X | | | 2 |
| CBE Technical Elective (See List on Requirements Tab) | | X | | | 3 |
| Chemistry Elective (See List on Requirements Tab) | | | X | | 3 |

| | | | | | |
|---|---|---|---|---|---|
| Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities) | | | X | 3B | 3 |
| The benchmark courses for the 10th semester are the remaining courses in the entire program of study | | X | | | |
| | **Total Credits** | | | | **15** |
| | **Program Total Credits:** | | | | **157** |