

# MAJOR IN CHEMICAL AND BIOLOGICAL ENGINEERING, ADVANCED MATERIALS CONCENTRATION

## Requirements Effective Fall 2026

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   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|------|-----------|
| CHEM 120 <sup>1</sup>                                                                                                                                                                                | Foundations of Modern Chemistry (GT-SC2)            | 3A   | 4         |
| CHEM 121 <sup>1</sup>                                                                                                                                                                                | Foundations of Modern Chemistry Laboratory (GT-SC1) | 3A   | 1         |
| CO 150                                                                                                                                                                                               | College Composition (GT-CO2)                        | 1A   | 3         |
| ENGR 111                                                                                                                                                                                             | Fundamentals of Engineering                         |      | 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         |
| 1C ( <a href="https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#aucc">https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#aucc</a> ) |                                                     | 1C   | 3         |
| <b>Total Credits</b>                                                                                                                                                                                 |                                                     |      | <b>29</b> |

### Sophomore

|                                                                                                                                                                                                                                                     |                                                 |    |           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|-----------|
| CBE 201                                                                                                                                                                                                                                             | Material and Energy Balances                    |    | 3         |
| CBE 205/BIOM 205                                                                                                                                                                                                                                    | Biological and Cellular 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         |
| Arts and Humanities ( <a href="https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities">https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities</a> ) |                                                 | 3B | 3         |
| <b>Total Credits</b>                                                                                                                                                                                                                                |                                                 |    | <b>33</b> |

### Junior

|                    |                                              |  |   |
|--------------------|----------------------------------------------|--|---|
| BC 351 or CHEM 321 | Principles of Biochemistry                   |  | 4 |
|                    | Foundations of Chemical Biology              |  |   |
| 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 |

|                                                                                                                                                                                                                                                                              |                                               |          |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------|------------|
| Bioscience Elective (see list below)                                                                                                                                                                                                                                         |                                               |          | 3          |
| Chemistry Electives (see list below)                                                                                                                                                                                                                                         |                                               |          | 6          |
| Historical Perspectives ( <a href="https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives">https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives</a> )              | 3D                                            |          | 3          |
| <b>Total Credits</b>                                                                                                                                                                                                                                                         |                                               |          | <b>33</b>  |
| <b>Senior</b>                                                                                                                                                                                                                                                                |                                               |          |            |
| 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          |
| Technical Elective (see list below)                                                                                                                                                                                                                                          |                                               |          | 9          |
| Advanced Writing ( <a href="https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing">https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing</a> )                                   | 2                                             |          | 3          |
| Arts and Humanities ( <a href="https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities">https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities</a> )                                  | 3B                                            |          | 3          |
| Social and Behavioral Sciences ( <a href="https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences">https://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences</a> ) | 3C                                            |          | 3          |
| <b>Total Credits</b>                                                                                                                                                                                                                                                         |                                               |          | <b>33</b>  |
| <b>Program Total Credits:</b>                                                                                                                                                                                                                                                |                                               |          | <b>128</b> |

<sup>1</sup> Students who complete General Chemistry (CHEM 111, CHEM 112, and CHEM 113, CHEM 114) do not have to take CHEM 120 and CHEM 121.

## Electives

The CBE program requires 18 credit hours of electives. 12 credits of electives will be taken from a subset of CBE electives within Chemistry electives and Technical electives to meet the requirements of the

concentration. The 3 credit bioscience elective will be from the entire bioscience elective list available to CBEs. The last 3 credits of technical electives can be from any elective list listed below. New courses are added all the time, if you find a course you believe is valuable to your education just ask your advisor if it is an appropriate elective course.

## Chemistry Electives

Select a minimum of 6 credits from the following.

| Code            | Title                               | AUCC | Credits |
|-----------------|-------------------------------------|------|---------|
| BC 411          | Physical Biochemistry               |      | 4       |
| BC 521/CHEM 521 | Principles of Chemical Biology      |      | 3       |
| CBE 310         | Molecular Concepts and Applications |      | 3       |
| CHEM 263        | Foundations of Inorganic Chemistry  |      | 4       |
| CHEM 311        | Introduction to Nanoscale Science   |      | 3       |
| CHEM 315        | Foundations of Polymer Chemistry    |      | 3       |
| CHEM 461        | Inorganic Chemistry                 |      | 3       |
| CHEM 462        | Inorganic Chemistry Laboratory      |      | 2       |
| CHEM 511        | Solid State Chemistry               |      | 3       |
| CHEM 515        | Polymer Chemistry                   |      | 3       |
| CHEM 517        | Chemistry of Electronic Materials   |      | 3       |
| CHEM 550A       | Materials Chemistry: Hard Materials |      | 1       |
| CHEM 550B       | Materials Chemistry: Soft Materials |      | 1       |
| CHEM 550C       | Materials Chemistry: Nanomaterials  |      | 1       |

## Bioscience Elective

Select a minimum of 3 credits from the following.

| Code            | Title                                             | AUCC | Credits |
|-----------------|---------------------------------------------------|------|---------|
| 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       |
| BMS 300         | Principles of Human Physiology                    |      | 4       |
| 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 360         | Fundamentals of Physiology                        |      | 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       |

|                 |                                                                        |    |   |
|-----------------|------------------------------------------------------------------------|----|---|
| LIFE 201B       | Introductory Genetics: Molecular/ Immunological/Developmental (GT-SC2) | 3A | 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 |
| 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 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 555         | Principles and Mechanisms of Disease                                   |    | 3 |

## Technical Electives

You need 9 credits total. 6 credits should be selected from the Technical Electives list A or Chemistry Electives List. 3 credits can be selected from Technical Electives List B or any other elective listed on this page.

| Code                              | Title                                      | AUCC | Credits |
|-----------------------------------|--------------------------------------------|------|---------|
| <b>Technical Electives List A</b> |                                            |      |         |
| BIOM 441                          | Biomechanics and Biomaterials              |      | 3       |
| BIOM 525/MECH 525                 | Cell and Tissue Engineering                |      | 3       |
| BIOM 574/MECH 574                 | Bio-Inspired Surfaces                      |      | 3       |
| CBE 514                           | Polymer Science and Engineering            |      | 3       |
| CBE 570                           | Biomolecular Engineering/Synthetic Biology |      | 3       |
| MECH 331                          | Introduction to Engineering Materials      |      | 4       |
| MECH 432                          | Engineering of Nanomaterials               |      | 3       |
| MECH 530                          | Advanced Composite Materials               |      | 3       |
| MECH 531/BIOM 531                 | Materials Engineering                      |      | 3       |
| MECH 532/BIOM 532                 | Materials Issues in Mechanical Design      |      | 3       |
| MECH 573/BIOM 573                 | Structure and Function of Biomaterials     |      | 3       |

|                  |                                                                                        |   |
|------------------|----------------------------------------------------------------------------------------|---|
| MSE 436/MECH 436 | Green Engineering--Materials and Environment                                           | 3 |
| 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 |
| MSE 523          | Electronic Properties of Materials                                                     | 3 |

| Code                              | Title                                                         | AUCC | Credits |
|-----------------------------------|---------------------------------------------------------------|------|---------|
| <b>Technical Electives List B</b> |                                                               |      |         |
| AB 410                            | Understanding Pesticides                                      |      | 3       |
| ATS 350                           | Introduction to Weather and Climate                           |      | 2       |
| ATS 351                           | Introduction to Weather and Climate Lab                       |      | 1       |
| ATS 440/GES 440                   | Sea Level Rise and a Sustainable Future                       |      | 3       |
| ATS 542/GEOL 542                  | Paleoclimate                                                  |      | 3       |
| ATS 543/ESS 543                   | Global Climate Change                                         |      | 2       |
| ATS 550                           | Atmospheric Radiation and Remote Sensing                      |      | 3       |
| ATS 555                           | Air Pollution                                                 |      | 3       |
| ATS 556                           | Climate Intervention to Cool a Warming Planet                 |      | 2       |
| ATS 560                           | Air Pollution Measurement                                     |      | 2       |
| BC 400-479                        |                                                               |      |         |
| BC 500-579                        |                                                               |      |         |
| BIOM 300                          | Problem-Based Learning Biomedical Engr Lab                    |      | 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 350C                         | Study Abroad--Ireland: Biomedical Engineering and Healthcare  |      | 1       |
| BIOM 421                          | Transport Phenomena in Biomedical Engineering                 |      | 3       |
| BIOM 422                          | Quantitative Systems and Synthetic Biology                    |      | 3       |
| BIOM 517/ECE 517                  | Advanced Optical Imaging                                      |      | 3       |

|                    |                                                             |   |
|--------------------|-------------------------------------------------------------|---|
| BIOM 518/ECE 518   | Biophotonics                                                | 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 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 576/MECH 576  | Quantitative Systems Physiology                             | 4 |
| BIOM 578/MECH 578  | Musculoskeletal Biosolid Mechanics                          | 3 |
| BIOM 579/MECH 579  | Cardiovascular Biomechanics                                 | 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 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 543            | Membranes for Biotechnology and Biomedicine                 | 3 |
| CBE 560            | Engineering of Protein Expression Systems                   | 3 |
| CBE 570            | Biomolecular Engineering/Synthetic Biology                  | 3 |
| CHEM 310-340       |                                                             |   |
| CHEM 350-379       |                                                             |   |
| CHEM 400-479       |                                                             |   |
| CHEM 500-579       |                                                             |   |
| CIVE 260           | Engineering Mechanics-Statics                               | 3 |
| CIVE 261           | Engineering Mechanics-Dynamics                              | 2 |
| 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 421          | Global Water Challenges                       | 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 441          | Water Quality Analysis and Treatment          | 2 |
| CIVE 442          | Air Quality Engineering                       | 3 |
| CIVE 515          | River Mechanics                               | 3 |
| CIVE 521          | Hydrometry                                    | 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                           | 4 |
| CS 270            | Computer Organization                         | 4 |
| ECE 204           | Introduction to Electrical Engineering        | 3 |
| ECE 430/MATH 430  | Fourier and Wavelet Analysis with Apps        | 3 |
| 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 and Reliability Analysis     | 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 353          | Global Change Impacts, Adaptation, Mitigation | 3 |
| ESS 440          | Practicing Sustainability                     | 4 |
| ESS 501          | Ecosystem Sustainability for Researchers      | 3 |
| ESS 524          | Foundations for Carbon/Greenhouse Gas Mgmt    | 3 |
| F 311            | Forest Ecology                                | 3 |
| FIN 305          | Fundamentals of Finance                       | 3 |
| FTEC 447         | Food Chemistry                                | 3 |
| GEOL 150         | Dynamic Earth (GT-SC2) 3A                     | 4 |
| GEOL 452         | Hydrogeology                                  | 4 |
| GEOL 454         | Geomorphology                                 | 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 |
| 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 |
| IDEA 310B        | Design Thinking Toolbox: 3D Modeling          | 3 |
| IDEA 310D        | Design Thinking Toolbox: Digital Imaging      | 1 |
| 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 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 262          | Engineering Mechanics                               | 4 |
| MECH 307          | Mechatronics II                                     | 3 |
| MECH 324          | Dynamics of Machines                                | 4 |
| MECH 325          | Machine Design with Finite Element Analysis         | 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/MSE 431  | Metals and Alloys                                   | 3 |
| MECH 436/MSE 436  | Green Engineering--Materials and Environment        | 3 |
| MECH 502/BIOM 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 543/BIOM 543 | Biofluid Mechanics                                  | 3 |
| MECH 552          | Applied Computational Fluid Dynamics                | 3 |
| MGT 305           | Fundamentals of Management                          | 3 |
| MGT 340           | Fundamentals of Entrepreneurship                    | 3 |
| MIP 425           | Virology and Cell Culture Laboratory                | 2 |
| MIP 543           | RNA Biology                                         | 3 |
| MIP 550           | Microbial and Molecular Genetics Laboratory         | 4 |
| MKT 305           | Fundamentals of Marketing                           | 3 |
| MSE 501           | Materials Technology Transfer                       | 1 |
| NR 319            | Introduction to Geospatial Science                  | 4 |
| NR 323/GR 323     | Remote Sensing and Image Interpretation             | 3 |
| NR 505            | Concepts in GIS                                     | 4 |
| PH 142            | Physics for Scientists and Engineers 3A II (GT-SC1) | 5 |
| 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 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         | Formal Logic                                  | 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 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 315         | Intro to Theory and Practice of Statistics    | 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 512         | Systems Sensing and Imaging Analysis          | 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 |
| SYSE 536         | Space Mission Analysis and Design             | 3 |
| SYSE 541         | Engineering Data Design and Visualization     | 3 |
| SYSE 544         | Systems-Based AR/VR Environmental Realism     | 3 |
| SYSE 545         | Augmented/Virtual Reality Systems Development | 3 |

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|----------|-----------------------------------------------|---|
| SYSE 548 | Security Engineering for Systems Engineers    | 3 |
| SYSE 549 | Secure Vehicle and Industrial Networking      | 3 |
| SYSE 555 | Transitions in Energy Systems                 | 3 |
| SYSE 567 | Systems Engineering Architecture              | 3 |
| SYSE 569 | Cybersecurity Awareness for Systems Engineers | 3 |
| SYSE 571 | Analytics in Systems Engineering              | 3 |
| SYSE 573 | Cost Optimization for Systems Engineers       | 3 |