Advanced computation is increasingly used in the design, optimization, control, and simulation of chemical and biochemical systems. If you are interested in these applications beyond what we normally include in our curriculum, consider a focus area in “Computation, Data Science, and Machine Learning.”

This FA is relevant to business cyber-physical systems, supply chain management, product design, process design, business decision making, next-generation controls, safety, systems engineering, grand challenges in medicine (personalized medicine, bioinformatics, drug design), and all domains of science.

Some recommendations:

* New course offerings pop up frequently in these rapidly evolving fields, so take some time and research what’s available.
* Prerequisites courses and prerequisite knowledge are important in some of these areas, which are based on successive development of programming and analytical skills. So take prerequisites seriously, but also talk to instructors about waiving prerequisites. The instructors we speak with (for example, in electrical, civil, environmental, and mechanical engineering) are sometimes willing to take chemical engineers for 3rd and 4th year courses even though they may lack formal prerequisites. It really depends on the course.

Steps to making your Computation, Data Science and Machine Learning FA work the best for you

**Step 1.** Think about whether you want to focus your efforts into a specialization such as automation and controls? This will help you decide the best foundational course to build from.

|  |  |  |
| --- | --- | --- |
| **Specialization** | **Description** | **Best Foundational Course** |
| None | Keeping it open and general. That’s fine. | Any of the foundational courses listed below |
| Quality Engineering | Measuring, Maximizing and Using Quality Measurements (“Analytics”) to Drive Manufacturing and Business Decisions. | ENGR:2995 Intro to AI and Machine Learning in Engineering\*\* |
| Controls & Communications | Collecting, transmitting, storing, and using large datasets derived from sensors (in conjuction with our Electrical and Computer Engineering Department) | ENGR:2730 Computers in Engineering |
| Automation and Robotics | Making things move intelligently based on sensed data and algorithms (in conjuction with our Electrical and Computer Engineering Department) | ME:4111 Scientific Computing and Machine Learning |
| Bioinformatics | Computations involving genetic sequences of genes, proteins, and viruses, usually for medical and pharamceutical research and development | ENGR:2730 Computers in Engineering\* |
| Software Development | Writing programs and apps in C++, Python, Java, Javascript, etc. | ENGR:2730 Computers in Engineering |
| Artificial Intelligence / Machine Learning | Learn to use and create algorithms for pattern recognition and prediction (image processing, natural language processing, etc.) | ENGR:2995 Intro to AI and Machine Learning in Engineering |
| Simulation of Chemical, Biological, Physical and Engineering Systems | Computer simulation of chemical and biochemical systems, combining heat and mass transfer with reactions – can be used at the molecular level, or for large systems such as the atmosphere | ENGR:2730 Computers in Engineering |

\*for Bioinformatics consider BIOC:3120 Biochemistry and Molecular Biology I and/or BIOL:1411 Foundations of Biology

\*\*for Quality Engineering consider MSCI:3500 Business Intelligence

**Step 2.** Choose a statistics course

We highly recommend

* CBE: 3020 Applied Statistics for Chemical and Natural Resources Engineering (offered Spring semesters)

But also accept

* STAT:2020 Probability & Stats for Engr & Phys Sci

And if you are interested in Bioinformatics, we also recommend

* STAT:3150 Biostatistics or BIOS:4120 Biostatistics

**Step 3.** Choose GEC and Advanced Science courses consistent with your interests.

**Free Electives (12 semester hours) –** *please note that many of these may have pre-requisites and you are encouraged to discuss prerequisites with course instructors, and map out an appropriate sequence*

|  |  |  |
| --- | --- | --- |
| **Engineering Electives**  ECE:2400  ENGR:2730  ENGR:2995  CBE:3998  ECE:2400  ECE:3330  CBE:3415  IE:3600  ME:4111  ME:4150  BME:4310  CEE:4511  CEE:4512  IE:4900  ME:5114  ME:5115  ME:5143  BME:5320 | Linear Systems I  Computers in Engineering  Intro to AI and Machine Learning in Engineering  Individual Investigations (*usually research*)  Linear Systems I  Introduction to Software Design  Statistical & Computational Analysis of Weather & Climate Data  Six Sigma Operations and Quality Control  Quality Control  Scientific Computing and Machine Learning  Artificial Intelligence in Engineering  Computational Biochemistry  Numerical Calculations  Engineering Design Optimization  Nonlinear Control in Robotic Systems  Cooperative Autonomous Systems  Computational Fluid and Thermal Engineering  Bioinformatics Techniques | 3 s.h.  3 s.h.  3 s.h.  3 s.h.  1-3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h. |
| CBE:5120 | Data Science in Chemical and Engineering Systems | 3 s.h. |
| ECE:5330  CBE:5417  ECE:5420  CBE:5426 | Graph Algorithms & Combinatorial Optimization  Physical Meteorology & Atmospheric Radiative Transfer  Power Electronics  Atmospheric Chemistry and Physics | 3 s.h.  3 s.h.  3 s.h.  3 s.h. |
| **Science Electives**  CS:2110  CS:2210  CS:2230  CS:3110  CS:3330  MSCI:3500  MATH:3770  MSCI:3800  MATH:3800  ACCT:4200  BIOL:4213  STAT:4740  CHEM:4480  BIOL:5320  CHEM:5431  MATH:5600  MATH:5700 | Programming for Informatics  Discrete Structures  Computer Science II: Data Structures  Introduction to Informatics  Algorithms  Business Intelligence  Fundamental Properties Spaces/Funct  Optimization and Simulation Modeling  Elementary Numerical Analysis  Acctg for Management Analysis & Control  Bionformatics  Large Data Analytics  Introduction to Molecular Modeling  Computational Genomics  Statistical Thermodynamics I  Nonlinear Dynamics with Numerical Methods  Partial Differential Equations with Numerical Methods  Discuss with advisor, courses with computational component in the sciences (i.e., physics, biochemistry, biology, etc.) | 3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h.  3 s.h. |

Note: students who take ENGR:2730, ECE:3330, CS:2210, CS:2230, and CS:3330 earn a computer science minor.