COMPUTATIONAL SCIENCE (SECOND MAJOR ONLY)

Computational methods are widely employed in science and engineering for simulation, experimentation, analysis, and design. In many areas the use of high-performance computing is essential. The Computational Science major provides Rose-Hulman students with the opportunity to add to their primary major a second major that increases their knowledge and skill in applied scientific and engineering computation.

Requirements

Requirements for a Second Major in Computational Science (72 credit hours)

The second major in Computational Science is open to all students. It requires 72 credit hours, including a 52 credit hour core and a 20 credit hour specialization. The courses used to satisfy the requirements in the Advanced Core may not be counted toward any other major or minor. All Computational Science programs of study are subject to approval by the Chair of the Computational Science Steering Committee.

Computational Science Core (52 credit hours)

Fundamentals (31 credit hours)

Code	Title	Hours
MA 111 & MA 112 & MA 113	Calculus I and Calculus II and Calculus III	15
MA 221	Matrix Algebra & Differential Equations I	4
MA 222	Matrix Algebra & Differential Equations II	4
Select one of the following:		4
CSSE 120	Introduction to Software Development	
BE 100	Problem Solving in the Biological Sciences & Engineering	
CE 111	Geographical Information Systems [1]	
CHE 110	Excel for Chemical Engineers [1]	
ENGD 120	Integrating Electrical, Software, and Societal Systems	
ME 123	Computer Programming	
Select one of the following:		4
MA 332	Introduction to Computational Science	
CHE 310	Numerical Methods for Chemical Engineers	
ME 327	Numerical Methods of Engineering Analysis	
Total Hours		**31**

[1] Courses marked with an asterisk carry only 2 credits and must be augmented by an additional 2 credits of course work, as approved by the Chair of the Computational Science Steering Committee.

Advanced (21 credit hours; these courses may not be counted toward any other major or minor)

Code	Title	Hours
CSSE/MA 335	Introduction to Parallel Computing	4
MA 336	Boundary Value Problems	4
MA 342 & MDS 442	Computational Modeling and Applied Computational Modeling	6
MDS 442	Applied Computational Modeling	2
MA 435 or ME 422	Finite Difference Methods or Finite Elements for Engineering Applications	4
Total Hours		**20**

Any course from the list of Approved Computational Science Electives (or another upper-level course if approved by the Chair of the Computational Science Steering Committee):

Code	Title	Hours
BMTH 312	Bioinformatics	4
BMTH 413	Computational Biology	4
CHE 310	Numerical Methods for Chemical Engineers	4
CE 310	Computer Applications in Civil Engineering	2
CSSE 304	Programming Language Concepts	4
ECE 480/OE 437	Introduction to Image Processing	4
ECE 483	DSP System Design	4
MA 323	Geometric Modeling	4
MA 384	Data Mining	4
MA 433	Numerical Analysis	4
MA 434	Topics In Numerical Analysis	4
MA 435	Finite Difference Methods	4
MA 439	Mathematical Methods of Image Processing	4
MA 444	Deterministic Models in Operations Research	4
MA 446	Combinatorial Optimization	4
ME 422	Finite Elements for Engineering Applications	4
ME 427	Introduction to Computational Fluid Dynamics	4
ME 230	Mechatronic Systems	4
ME 522	Advanced Finite Element Analysis	4
ME 536	Computational Intelligence in Control Engineering	4
PH 540	Computer Physics	4

Area of Concentration (20 credit hours)

Each student must complete 20 credit hours of advanced work reflecting an Area of Concentration within Computational Science. Courses used to satisfy the core requirements may not be used to satisfy the area of concentration requirements. The 20 credit hours shall consist of at least 16 credit hours within a single Area of Concentration, as specified below, and an additional 4 credit hours from any of the Areas of Concentration, or from the list of Approved Computational Science Electives. Exceptions may be made on occasion (e.g. when an appropriate special topics course has been taken).

Computational Methods

Code	Title	Hours
MA 371 or MA 373	Linear Algebra I or Applied Linear Algebra for Engineers	4
MA 433	Numerical Analysis	4
Select eight credit hours from the following:		8
BMTH 413	Computational Biology	

CSSE 304	Programming Language Concepts	
CSSE/MA 473	Design and Analysis of Algorithms	
MA 384	Data Mining	
MA 386	Statistical Programming	
MA 434	Topics In Numerical Analysis	
MA 435	Finite Difference Methods	
MA 439	Mathematical Methods of Image Processing	
MA 444	Deterministic Models in Operations Research	
MA 446	Combinatorial Optimization	
MA 485	Applied Linear Regression	
ME 422	Finite Elements for Engineering Applications	
Total Hours		**16**

Computational Mechanics

Code	Title	Hours
MA 435	Finite Difference Methods	4
or ME 422	Finite Elements for Engineering Applications	
ME 401	Foundations of Fluid Mechanics	4
ME 427	Introduction to Computational Fluid Dynamics	4
ME 522	Advanced Finite Element Analysis	4
Total Hours		**16**

Computational Signals and Image Processing

Code	Title	Hours
ECE 380	Discrete-Time Signals and Systems	4
ECE 480/OE 437	Introduction to Image Processing	4
ECE 483	DSP System Design	4
MA 439	Mathematical Methods of Image Processing	4
Total Hours		**16**

Computational Physics and Chemistry

Code	Title	Hours
CHEM 361	Physical Chemistry I [1]	4
CHEM 362	Physical Chemistry II [1]	4
OE 450	Laser Systems & Applications	4
PH 540	Computer Physics	4
Total Hours		**16**

[1]   For CHE students, CHEM 361 Physical Chemistry I and CHEM 362 Physical Chemistry II may be substituted by CHE 303 Chemical Engineering Thermodynamics, CHE 304 Multi-Component Thermodynamics and CHEM 360 Introduction to Physical Chemistry for Engineers

Computational Biomedics

Code	Title	Hours
BE/MA 482	Biostatistics	4
BE/OE 535	Biomedical Optics	4
BE 541/ECE 584	Medical Imaging Systems	4
BMTH 310	Mathematical Biology	4
BMTH 413	Computational Biology	4
Total Hours		**20**

Learning Outcomes
Computational Science Program Student Learning Objectives

Graduates with a second major in CPLS will have an ability to:

1. Develop goals for a computational model such that the results will inform a scientific/engineering decision or provide a desired level of understanding

2. Choose a computational modelling approach that meets the goals and implement it

3. Validate a computational model of a complex phenomenon or system and demonstrate that the goals have been met