Requirements: Scientific Computing

Interdisciplinary

The Scientific Computing Concentration is an interdisciplinary program in the application of computers to scientific inquiry. A longer title for the program might be "Computing within a Scientific Context."

The concentration focuses on four major areas:

1. computer program development, including the construction and implementation of data structures and algorithms
2. mathematical modeling of natural phenomena (including cognitive processes) using quantitative or symbolic computer techniques
3. analysis and visualization of complex data sets, functions and other relationships using the computer
4. computer hardware issues, including the integration of computers with other laboratory apparatus for data acquisition

The overall aim is to prepare the student to use computers in a variety of ways for scientific exploration and discovery.

The Curriculum

The concentration in scientific computing requires a total of three (3) units of Kenyon coursework. SCMP 118 Introduction to Computer Science serves as a foundation course for the program, introducing students to programming and other essential ideas of computer science.

Contributory courses have been identified in biology, chemistry, economics, environmental studies, mathematics, political science and physics. In these courses, computational methods form an essential means for attacking problems of various kinds.

Students in the concentration also will take at least one-half (0.5) unit of intermediate scientific computing courses. These courses have computational methods as their main focus and develop or investigate these methods extensively.

In addition to regular courses that are identified as contributory or intermediate, particular special-topics courses or individual studies in various departments may qualify in one of these two categories. Students who wish to credit such a course toward the concentration in scientific computing should contact the program director at the earliest possible date.

The capstone course of the program is SCMP 401 Advanced Scientific Computing, a project-oriented, seminar-style course for advanced students.

Requirements for the Concentration

Required Courses

SCMP 118 Introduction to Programming or PHYS 270 Introduction to Computational Physics
SCMP 401 Scientific Computing Seminar

Contributory Courses

BIOL 109Y–110Y Introduction to Experimental Biology
BIOL 328 Global Ecology and Biogeography

CHEM 126 Introductory Chemistry Laboratory II
CHEM 336 Quantum Chemistry
CHEM 341 Instrumental Analysis
CHEM 370 Advanced Lab: Computational Chemistry
CHEM 374 Advanced Lab: Spectroscopy
ECON 205 Introduction to Econometrics
ECON 337 Portfolio Allocation and Asset Pricing
ECON 375 Advanced Econometrics
ENVS 261 Geographic Information Science
MATH 106 Elements of Statistics
MATH 116 Statistics in Sports
MATH 206 Data Analysis
MATH 216 Nonparametric Statistics
PHYS 140 Classical Physics
PHYS 141 First Year Seminar in Physics
PHYS 146 Introduction to Experimental Physics
PHYS 240, 241 Fields and Spacetime and Laboratory
PHYS 345 Astrophysics and Particles
PHYS 380 Introduction to Electronics
PHYS 381, 382 Projects in Electronics 1, 2
PHYS 385, 386, 387 Advanced Experimental Physics 1, 2, 3
PSCI 280 Political Analysis
PSYC 410 Research Methods in Human Neuroscience

Intermediate Courses

BIOL 291 Computational Genomics
MATH 258 Mathematical Biology
MATH 328 Coding Theory and Cryptography
MATH 347 Mathematical Models
MATH 348 Software System Design
MATH 368 Design and Analysis of Algorithms
MATH 416 Linear Regression Models
PHYS 218 Dynamical Systems and Scientific Computing
PHYS 219 Complex Systems in Scientific Computing
SCMP 218 Data Structures and Program Design
SCMP 318 Software Development
SCMP 493 Individual Study
STAT 291 Statistical Computing with R

Courses in Scientific Computing

SCMP 118 INTRODUCTION TO PROGRAMMING

Credit: 0.5 QR

This course presents an introduction to computer programming intended both for those who plan to take further courses in which a strong background in computation is desirable and for those who are interested in learning basic programming principles. The course will expose the student to a variety of applications where an algorithmic approach is natural and will include both numerical and non-numerical computation. The principles of program structure and style will be emphasized. SCMP 118 may be paired with SCMP 218 or either may be paired with any mathematics or statistics

course to satisfy the natural science diversification requirement. No prerequisite. Offered every semester.

SCMP 218 DATA STRUCTURES AND PROGRAM DESIGN

Credit: 0.5

This course is intended as a second course in programming, as well as an introduction to the concept of computational complexity and the major abstract data structures (such as dynamic arrays, stacks, queues, link lists, graphs and trees), their implementation and application, and the role they play in the design of efficient algorithms. Students will be required to write a number of programs using a high-level language. SCMP 218 may be paired with SCMP 118 or either may be paired with any mathematics or statistics course to satisfy the natural science diversification requirement. Prerequisite: SCMP 118 or PHYS 270 or permission of instructor. Offered every other spring.

SCMP 318 SOFTWARE DEVELOPMENT

Credit: 0.5

This course gives students experience designing, implementing, testing and debugging moderately complex systems of software components that collectively form a multilayer application. There will be an emphasis on crafting quality code, designing and implementing effective user interfaces, and building multicomponent architectures using a mix of off-the-self and custom code. Topics will include inner process and inter-system communication, multi-threading, and the synchronization of shared resources, web interfaces and working with large data sets. Students will primarily use C++, but also will learn Javascript and other languages as needed. Prerequisite: MATH 138 (SCMP 191 in 2018-19), SCMP 118 or permission of instructor.

SCMP 401 SCIENTIFIC COMPUTING SEMINAR

Credit: 0.5 QR

This capstone course is intended to provide an in-depth experience in computational approaches to science. Students will work on individual computational projects in various scientific disciplines. Each student will give several presentation to the class throughout the semester. Permission of the instructor and program director required. Prerequisite: SCMP 118 or PHYS 270, senior standing, completion of at least 0.5 units of an intermediate course and at least 0.5 units of a contributory course.

SCMP 493 INDIVIDUAL STUDY

Credit: 0.25-0.5

The Individual Study is to enable students to explore a pedagogically valuable topic in computing applied to the sciences that is not part of a regularly offered SCMP course. A student who wishes to propose an individual study course must first find a SCMP faculty member willing to supervise the course. The student and faculty member then craft a course syllabus that describes in detail the expected coursework and how a grade will be assigned. The amount of credit to be assigned to the IS course should be determined with respect to the amount of effort expected in a regular Kenyon class. The syllabus must be approved by the director of the SCMP program. In the case of a small group IS, a single syllabus may be submitted and all students must follow the same syllabus. Because students must enroll for individual studies by the end of the seventh class day of each semester, they should begin discussion of the proposed individual study preferably the semester

before, so that there is time to devise the proposal and seek departmental approval before the registrar's deadline. Permission of the instructor and program director required. No prerequisite.

ADDITIONAL COURSES THAT MEET THE REQUIREMENTS FOR THIS CONCENTRATION:

BIOL 109Y: Introduction to Experimental Biology
BIOL 110Y: Introduction to Experimental Biology
BIOL 230: Computational Genomics
BIOL 328: Global Ecology and Biogeography
CHEM 126: Introductory Chemistry Lab II
CHEM 336: Quantum Chemistry
CHEM 341: Instrumental Analysis
CHEM 370: Advanced Lab: Computational Chemistry
CHEM 374: Advanced Lab: Spectroscopy
ECON 205: Introduction to Econometrics
ECON 337: Portfolio Allocation and Asset Pricing
ECON 375: Advanced Econometrics
ENVS 261: Geographic Information Science
MATH 258: Mathematical Biology
MATH 328: Coding Theory and Cryptography
MATH 347: Mathematical Models
PHYS 140: Classical Physics
PHYS 141: First Year Seminar in Physics
PHYS 146: Modern Physics Lab
PHYS 240: Fields and Spacetime
PHYS 241: Fields and Spacetime Laboratory
PHYS 345: Astrophysics and Particles
PHYS 380: Introduction to Electronics
PHYS 381: Projects in Electronics 1
PHYS 382: Projects in Electronics 2
PHYS 385: Advanced Experimental Physics 1
PHYS 386: Advanced Experimental Physics 2
PHYS 387: Advanced Experimental Physics 3
PHYS 493: Individual Study
PSCI 280: Political Analysis
PSYC 410: Advanced Research Methods in Human Neuroscience
STAT 106: Elements of Statistics
STAT 116: Statistics in Sports
STAT 206: Data Analysis
STAT 216: Nonparametric Statistics
STAT 416: Linear Regression Models