Interdisciplinary Programs

Carnegie Mellon University offers several degree programs and courses of study which are coordinated by multiple colleges, reflecting the interdisciplinary nature of the university. These are detailed below.

Intercollege Majors
- BXA Intercollege Degree Programs
  - Bachelor of Humanities and Arts Program
  - Bachelor of Science and Arts Program
  - Bachelor of Computer Science and Arts Program
- B.S. in Computational Finance
- B.S. in Music and Technology
- B.S. in Neuroscience
- B.S. in Psychology and Biological Sciences

Intercollege Minors
- Minor in Computational Finance
- Minor in Game Design (IDeATe)
- Minor in Health Care Policy and Management

BXA Intercollege Degree Programs
The BXA Intercollege Degree Programs enable students the freedom to individualize their educational experience by promoting integration, balance and innovation. There are three degree programs from which to choose:
- Bachelor of Humanities and Arts
- Bachelor of Science and Arts
- Bachelor of Computer Science and Arts

For detailed information on the BXA Intercollege Degree Programs, go to BXA Intercollege Degree Programs (http://coursecatalog.web.cmu.edu/servicesandoptions/intercollegeprograms/bxa/intercollege).

Bachelor of Science in Computational Finance
The Mellon College of Science, the Heinz College of Public Policy and Management and the Tepper School of Business jointly offer a degree uniquely designed to meet the quantitative needs of the finance industry. Modeled after the highly successful Carnegie Mellon Master of Science in Computational Finance, this degree allows students to develop a deep knowledge of mathematics, probability, statistics, and the applications of these disciplines to finance. Students who complete this degree may directly enter the finance industry, enter other industries where applied mathematics training is appropriate, or pursue advanced degrees in economics, finance or the mathematical sciences. Students entering the work force upon completion of this degree may wish to later complement their undergraduate degree with a Master’s degree in Business Administration or another professional degree. Students who might eventually pursue doctoral degrees in economics, finance, statistics or mathematics should seek advising on how to use their electives in order to prepare for graduate work in their chosen disciplines.

Students must apply to enroll in the Computational Finance major. Applications are accepted each Fall and Spring semester, just after mid-semester. Applicants must have taken (or be currently taking) 21-270 Introduction to Mathematical Finance at the time of application. Students from any college or program at Carnegie Mellon are welcome to apply to enroll in the major.

The Bachelor of Science in Computational Finance is an Intercollegiate Program. Students who pursue Computational Finance as their primary major may elect to have either the Mellon College of Science (MCS) or the Tepper School of Business (Tepper) as their home college. The coursework required for the major is essentially the same in each case, with a few minor exception outlined below. The general education requirements for the degree depend on the student’s home college.

Students who pursue Computational Finance as an additional major will remain in the college of their primary major. Additional majors must complete the Major Requirements outlined below, but not the General Education Requirements outlined for MCS and Tepper students.

Majors in Computational Finance may tailor their degree program by selecting Depth Electives aligned with their interests and ambitions. MCS students are required to take three depth electives. Tepper students must take 70-391 Finance as one of their three depth electives. (MCS students may also select 70-391 as one of their three depth electives.)

Additional information about computational finance and the Undergraduate Computational Finance Program at Carnegie Mellon can be found on the BSCF Program website.

Major Requirements
The major in Computational Finance is built around a core sequence of study in mathematical finance. This core is augmented with coursework in the related areas of Statistics, Computer Science, and Economics. Additionally the major provides training in the “soft skills” required for work in a corporate environment. The major also requires the completion of several depth electives, allowing students to tailor their education to their particular interests and needs.

The major requirements are the same for additional majors as they are for majors whose home college is MCS. There are a few slight differences for students whose home college is Tepper. These differences are described in the sections for Depth Electives and Professional Development below.

Foundations
- 21-120 Differential and Integral Calculus 10
- 21-122 Integration and Approximation 10
- 21-127 Concepts of Mathematics 10
- 21-241 Matrices and Linear Transformations 10
- 21-259 Calculus in Three Dimensions 9
- 21-260 Differential Equations 9
- 21-369 Numerical Methods 12
- 70-122 Introduction to Accounting 9

Mathematical Finance
- 21-270 Introduction to Mathematical Finance 9
- 21-370 Discrete Time Finance 9
- 21-420 Continuous-Time Finance 9
- 46-977 MSCF Studies in Financial Engineering 6

Statistics
- 21-325 Probability 9
- 36-226 Introduction to Statistical Inference 9
- 36-401 Modern Regression 9

Programming
- 15-110 Principles of Computing 10
- 15-112 Fundamentals of Programming and Computer Science 12
- 15-122 Principles of Imperative Computation 10

Economics
- 73-102 Principles of Microeconomics 9
- 73-103 Principles of Macroeconomics 9
- 73-240 Intermediate Macroeconomics 9

Professional Development

Majors in the Tepper School of Business take 70-311 Organizational Behavior as part of the Functional Business Core curriculum. This course counts in place of 94-700 Organizational Design & Implementation.

- 94-700 Organizational Design & Implementation 6
- 94 or 70-311 Organizational Behavior 6
- 95-717 Writing for Information Systems Management 6
- or 70-340 Business Communications 6
- 90-718 Strategic Presentation Skills 6

Depth Electives
Depth electives give students an opportunity to tailor their coursework to their particular interests. Students completing the major will take three depth electives (the minimum requirement is 24 units - the equivalent of
two 9 unit courses and one 6 unit course). Tepper students are required to select 70-391 Finance as one of their depth electives.

Depth electives are intended to develop a student's background in an area that is applicable to the finance industry. Courses in finance or programming generally qualify as depth electives. Mathematics, Statistics, or Economics courses in subjects applicable to finance also qualify. Computational Finance majors may have the opportunity to take MSCF courses (as described below) and these may also be counted as depth electives.

There is no definitive list of approved depth electives. The courses listed below have been taken as depth electives in recent years, but other courses could be approved upon request.

10-401 Introduction to Machine Learning (Undergrad) 12
10-601 Introduction to Machine Learning (Master's) 12
10-605 Machine Learning with Large Datasets 12
15-150 Principles of Functional Programming 10
15-210 Parallel and Sequential Data Structures and Algorithms 12
15-213 Introduction to Computer Systems 12
15-351 Algorithms and Advanced Data Structures 12
15-451 Algorithm Design and Analysis 12
21-393 Operations Research II 9
21-355 Principles of Real Analysis I 9
21-366 Topics in Applied Mathematics 9
21-372 Partial Differential Equations and Fourier Analysis 9
21-378 Mathematics of Fixed Income Markets 9
36-402 Advanced Methods for Data Analysis 9
36-410 Introduction to Probability Modeling 9
36-462 Special Topics: Data Mining 9
36-463 Special Topics: Multilevel and Hierarchical Models 9
36-464 Special Topics: Applied Multivariate Methods 9
70-391 Finance 9
70-492 Investment Analysis 9
70-495 Corporate Finance 9
70-497 Derivative Securities 9
80-150 Nature of Reason 9
80-180 Nature of Language 9
80-208 Critical Thinking 9
80-220 Philosophy of Science 9
80-221 Philosophy of Social Science 9
80-222 Measurement and Methodology 9
80-241 Ethical Judgments in Professional Life 9
80-242 Conflict and Dispute Resolution 9
80-270 Philosophy of Mind 9
80-271 Philosophy and Psychology 9
80-312 Mathematical Revolutions 9
80-330 Ethical Theory 9
85-102 Introduction to Psychology 9
85-211 Cognitive Psychology 9
85-221 Principles of Child Development 9
85-241 Social Psychology 9
85-251 Personality 9
85-261 Abnormal Psychology 9
85-390 Human Memory 9
88-120 Reason, Passion and Cognition 9

MSCF Courses

Computational Finance majors are required to take 46-977 MSCF Studies in Financial Engineering. They may also have the opportunity to take up to four more MSCF courses. Permission to enroll in these courses requires (1) approval from their BSCF Advisor, (2) approval of the course instructor, and (3) space available in the course. The MSCF curriculum (https://www.cmu.edu/mscf/academics/curriculum) with course descriptions is described on the MSCF website (https://www.cmu.edu/mscf).

Some MSCF courses cover material in the undergraduate curriculum and thus are not generally suitable. Other courses require background that is difficult to obtain as an undergraduate. Students interested in taking MSCF courses are encouraged to discuss their interest with their advisor as early as possible.

General Education Requirements for MCS Students

Students in the Mellon College of Science completing the Computational Finance major as their primary major must complete the requirements below in addition to the major requirements.

99-101 Computing @ Carnegie Mellon 3
76-101 Interpretation and Argument 9

Science Requirement

Two of the following:
03-121 Modern Biology 9
09-105 Introduction to Modern Chemistry I 10
33-111 Physics I for Science Students 12

Cognition, Choice, and Behavior

One of the following:
73-240 Intermediate Macroeconomics 9
80-100 Introduction to Philosophy 9
80-130 Introduction to Ethics 9

80-130 Critical Thinking 9
80-208 Philosophy of Science 9
80-221 Philosophy of Social Science 9
80-222 Measurement and Methodology 9
80-241 Ethical Judgments in Professional Life 9
80-242 Conflict and Dispute Resolution 9
80-270 Philosophy of Mind 9
80-271 Philosophy and Psychology 9
80-312 Mathematical Revolutions 9
80-330 Ethical Theory 9
85-102 Introduction to Psychology 9
85-211 Cognitive Psychology 9
85-221 Principles of Child Development 9
85-241 Social Psychology 9
85-251 Personality 9
85-261 Abnormal Psychology 9
85-390 Human Memory 9
88-120 Reason, Passion and Cognition 9

Non-Technical Electives

Two more courses must taken from any of the departments in DC, CFA or Tepper, subject to the list of deletions (https://www.cmu.edu/mcs/undergrad/advising/hss-finearts/deletions.html) and additions (https://
Interdisciplinary Programs

General Education Requirements for Tepper Students

Students in the Tepper School of Business completing the Computational Finance major as their primary major must complete the requirements below in addition to the major requirements.

Tepper Functional Business Core

The Functional Business Core of the Undergraduate Business Administration Program includes 70-122 Introduction to Accounting, which is required by all Computational Finance majors. It also includes 70-391 Finance, which Tepper students majoring in Computational Finance must select as one of their Depth Electives. In addition, Tepper students pursuing the B.S. in Computational Finance must complete six other courses from the Functional Business Core.

These courses are:
- 70-106 Business Science
- 70-311 Organizational Behavior
- 70-332 Business, Society and Ethics
- 70-371 Operations Management
- 70-381 Marketing I
- 70-401 Management Game

Liberal Arts & Sciences Breadth Requirements

Candidates for the B.S. in Computational Finance must complete the Liberal Arts & Sciences Breadth Requirements as described in the catalog entry for the B.S. Degree in Business Administration.

Sample Curricula

MCS Sample Curriculum

What follows is the detailed curriculum for the degree Bachelor of Science in Computational Finance in the Mellon College of Science. This is an example of how an MCS student might meet the requirements of the Computational Finance major. It is not expected that every student will follow this sequence. In particular, well prepared students should consider taking 21-270 Introduction to Mathematical Finance during their Freshman Spring semester. Students intending to do so are encouraged to take 21-127 Concepts of Mathematics or 21-241 Matrices and Linear Transformations during their Freshman Fall semester.

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Spring</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>21-122 Integration and Approximation</td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>70-122 Introduction to Accounting</td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
<td>xx-xxx Science Requirement</td>
</tr>
<tr>
<td>xx-xxx Science Requirement</td>
<td>xx-xxx Elective</td>
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Sophomore

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-241 Matrices and Linear Transformations</td>
<td>21-270 Introduction to Mathematical Finance</td>
</tr>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>21-127 Concepts of Mathematics</td>
</tr>
<tr>
<td>21-260 Differential Equations</td>
<td>21-369 Numerical Methods</td>
</tr>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>73-103 Principles of Macroeconomics</td>
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<tr>
<td>xx-xxx Humanities, Social Sciences, or Fine Arts Elective</td>
<td>xx-xxx Elective</td>
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</tbody>
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Junior

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>21-325 Probability</td>
<td>21-420 Continuous-Time Finance</td>
</tr>
<tr>
<td>21-370 Discrete Time Finance</td>
<td>36-226 Introduction to Statistical Inference</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>xx-xxx Humanities, Social Sciences, or Fine Arts Elective</td>
</tr>
<tr>
<td>15-122 Principles of Imperative Computation</td>
<td>xx-xxx Humanities, Social Sciences, or Fine Arts Elective</td>
</tr>
<tr>
<td>xx-xxx Elective</td>
<td>xx-xxx Depth Elective</td>
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</table>

Senior

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>46-977 MSCF Studies in Financial Engineering</td>
<td>95-717 Writing for Information Systems Management</td>
</tr>
<tr>
<td>94-700 Organizational Design &amp; Implementation</td>
<td>90-718 Strategic Presentation Skills</td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
<td>xx-xxx Depth Elective</td>
</tr>
<tr>
<td>xx-xxx Elective</td>
<td>xx-xxx Humanities, Social Sciences, or Fine Arts Elective</td>
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<td>xx-xxx Elective</td>
<td>xx-xxx Elective</td>
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<tr>
<td>xx-xxx Elective</td>
<td>xx-xxx Elective</td>
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</tbody>
</table>

Tepper Sample Curriculum

What follows is the detailed curriculum for the degree Bachelor of Science in Computational Finance in the Tepper School of Business. This is an example of how a Tepper student might meet the requirements of the Computational Finance major. It is not expected that every student will follow this sequence. In particular, well prepared students should consider taking 21-270 Introduction to Mathematical Finance during their Freshman Spring semester. Students intending to do so are encouraged to take 21-127 Concepts of Mathematics or 21-241 Matrices and Linear Transformations during their Freshman Fall semester.
Computational Finance program.

The minor by contacting the Associate Director of the Undergraduate

must satisfy one of the following sets of requirements:

However in order to declare the minor in Computational Finance, a student

There is no application process for the minor in Computational Finance,

Minor in Computational Finance

Concepts of Mathematics or 21-241 Matrices and Linear Transformations
during their Freshman Fall semester.

Freshman

Fall                      Spring
21-120 Differential and Integral Calculus 21-122 Integration and Approximation
73-102 Principles of Microeconomics 21-241 Matrices and Linear Transformations
70-106 Business Science                  73-103 Principles of Macroeconomics
76-101 Interpretation and Argument        xx-xxx Breadth Course
99-101 Computing @ Carnegie Mellon        xx-xxx Breadth Course

Sophomore

Fall                      Spring
21-127 Concepts of Mathematics            21-270 Introduction to Mathematical Finance
21-259 Calculus in Three Dimensions        21-325 Probability
21-260 Differential Equations             70-311 Organizational Behavior
70-122 Introduction to Accounting          70-381 Marketing I
xx-xxx Elective                          73-240 Intermediate Macroeconomics

Junior

Fall                      Spring
21-369 Numerical Methods                  21-420 Continuous-Time Finance
21-370 Discrete Time Finance              36-226 Introduction to Statistical Inference
70-391 Finance                        70-371 Operations Management
15-122 Principles of Imperative Computation xx-xxx Breadth Course
xx-xxx Elective                          xx-xxx Breadth Course

Senior

Fall                      Spring
36-401 Modern Regression                95-717 Writing for Information Systems Management
46-977 MSCF Studies in Financial Engineering 90-718 Strategic Presentation Skills
70-332 Business, Society and Ethics       xx-xxx Depth Elective
70-401 Management Game                  xx-xxx Breadth Course
xx-xxx Depth Elective                    xx-xxx Breadth Course
xx-xxx Elective                          xx-xxx Elective

21-243 Matrices and Linear Transformations 10
or 21-242 Matrix Theory
21-259 Calculus in Three Dimensions 9-10
or 21-256 Multivariate Analysis
or 21-268 Multidimensional Calculus
or 21-269 Vector Analysis
21-260 Differential Equations 9-10
or 21-261 Introduction to Ordinary Differential Equations
21-270 Introduction to Mathematical Finance 9
21-370 Discrete Time Finance * 9
21-420 Continuous-Time Finance ** 9

To avoid excessive double counting, Computational Finance minors may not
count 21-270 Introduction to Mathematical Finance, 21-370 Discrete Time
Finance or 21-420 Continuous-Time Finance toward any other requirement.

* The prerequisites for 21-370 are 21-270 and either 21-256 or 21-259, and
the co-requisite is 70-207, 21-325 , 36-225 or 36-217. Note that 70-207 is not accepted as a prerequisite for 21-420.

** The prerequisites for 21-420 are 21-260, 21-370 and one of the
following three calculus based probability courses: 21-256 , 36-225 or 36-217. Note that 70-207 is not a sufficient preparation in probability. Also note that 21-122 is a prerequisite for 21-260 and that 21-127 is recommended for 21-241.

Students minoring in Computational Finance are strongly encouraged to
take one or two economics course, e.g., 73-102, 73-103, 73-230 , or 73-240

Game Design Minor – IDeATe

The Game Design minor is offered by the Entertainment Technology
Center as part of the Integrative Design, Arts and Technology (IDeATe)
network. IDeATe offers students the opportunity to become immersed in a collaborative community of faculty and peers who share expertise, experience, and passions at the intersection of arts and technology.

Students will engage in active “learning by doing” in shared labs and maker spaces. The program addresses current and emerging real-world challenges that require disciplinary expertise coupled with multidisciplinary perspectives and collaborative integrative approaches.

The IDeATe undergraduate curriculum consists of eight areas, all of which can also be taken as minors. The themes of these areas integrate knowledge in technology and arts: Game Design, Animation & Special Effects, Media Design, Design for Learning, Sonic Arts, Innovation and Entrepreneurship, Intelligent Environments, and Physical Computing. For more information about the IDeATe network, please visit Undergraduate Options (http://coursescatalog.web.cmu.edu/servicesandoptions/
undergraduateoptions/#ideate).

Students in IDeATe’s Game Design minor learn both theory and practice of game creation taught by faculty experts from across the university. These experts specialize in: game systems and mechanics design, interactive narrative and character development, visual asset creation and sound synthesis, game programming, and interface design. These disciplines combine with each other in every step of development. In these courses, students learn to apply specialized knowledge from their own majors to enhance these game industry specific areas. In so doing, they work in highly interdisciplinary and collaborative teams to develop effective, engaging, and engrossing games.

Minor in Computational Finance

There is no application process for the minor in Computational Finance, however in order to declare the minor in Computational Finance, a student must satisfy one of the following sets of requirements:

1. Completion of 21-270 Introduction to Mathematical Finance with a grade of A and an overall QPA of at least 3.20;
2. Completion of 21-270 Introduction to Mathematical Finance and 21-370 Discrete Time Finance with an average grade of B and an overall QPA of at least 3.00; OR

When a student has met the necessary requirements, he or she may declare the minor by contacting the Associate Director of the Undergraduate Computational Finance program.

Curriculum

One Computing Course - Minimum of 9 Units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>15-104 Introduction to Computing for Creative Practice</td>
<td>10</td>
</tr>
<tr>
<td>15-110 Principles of Computing</td>
<td>10</td>
</tr>
<tr>
<td>15-112 Fundamentals of Programming and Computer Science</td>
<td>12</td>
</tr>
<tr>
<td>60-210 Electronic Media Studio: Introduction to Interactivity</td>
<td>10</td>
</tr>
<tr>
<td>60-212 Electronic Media Studio: Interactivity and Computation for Creative Practice</td>
<td>12</td>
</tr>
</tbody>
</table>

One IDeATe Portal Course - Minimum of 9 Units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>62-150 IDeATe Portal: Introduction to Media Synthesis and Analysis</td>
<td>10</td>
</tr>
</tbody>
</table>
Complete a minimum of 18 units from these two sections:

Elective Courses

Required Courses for HCPM Minor

A total of 54 units are required to complete this minor. Entry into the minor requires completion of 73-102 Principles of Microeconomics or the equivalent by approval.

Required Courses

Complete a total of 27 units from the following:

- 79-330 Medicine and Society 9
- 90-836 Health Systems 6
- 90-721 Healthcare Management 6
- 90-861 Health Policy 6

Elective Courses

Complete a minimum of 18 units from these two sections:

IDeATe Game Design Courses - Minimum of 27 Units

- 05-418 Design Educational Games 12
- 15-466 Computer Game Programming 12
- 53-230 Programming for Game Designers 12
- 53-353 Understanding Game Engines 9
- 53-371/53-368 Role Playing Games Writing Workshop 12
- 53-376 360 Story and Sound 12
- 53-409 Game Design 12
- 53-451 Research Issues in Game Development: Designing for XR 12
- 53-471 Game Design, Prototyping and Production 15
- 53-472 Advanced Game Studio 9
- 53-558 Reality Computing Studio 12
- 60-333 IDeATe: Character Rigging for Production 10
- 60-419 Advanced ETB: Experimental Game Design 10

Additional courses as available. Please refer to the IDeATe website for the list of Game Design courses for the current and upcoming semesters.

Double-Counting

Students may double-count up to two of their Game Design minor courses toward requirements for other majors or minors.

Minor in Health Care Policy and Management

Sponsored by:
Heinz College of Information Systems and Public Policy
Dietrich College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:
Jason D’Antonio, Mellon College of Science
James F. Jordan, H. John Heinz III College

The face of health care is changing. The practice of medicine is being fundamentally altered by the forces of change in public policy, health care organizations and in the industry as a whole. The role of individual professionals in this industry is changing as rapidly as the industry itself. Traditional career paths have disappeared overnight to be replaced by new opportunities that require new skills. New organizations are placing new demands on their professional and medical staffs. The criteria of efficiency and financial stability are entering the domains of diagnosis and treatment.

This minor is designed to provide students considering a career in the health professions with an understanding of how these changes are likely to affect their careers. Students will become familiar with the critical policy and management issues and will begin to learn to operate effectively in the emerging health care environment. The curriculum combines economic, organizational, managerial, historical and psychological perspectives on these issues to provide a foundation for a deeper understanding of the changing structure of health care organizations and policy.

Required Courses for HCPM Minor

A total of 54 units are required to complete this minor. Entry into the minor requires completion of 73-102 Principles of Microeconomics or the equivalent by approval.

Required Courses

Complete a total of 27 units from the following:

- 90-831 Advanced Financial Management of Health Care 6
- 94-705 Health Economics 12
- 90-832 Health Law 6
- 90-833 Population Health 6
- 90-818 Health Care Quality & Performance Improvement 6
- 90-834 Health Care Geographical Information Systems 12

Other courses as approved

Humanities and Social Sciences Courses (9 units each)

- 80-245 Medical Ethics 9
- 76-494 Healthcare Communications 9
- 88-365 Behavioral Economics and Public Policy 9
- 67-476 Innovation in Information Systems: Health Care 9
- 42-444 Medical Devices 9

Other courses as approved

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

Elective Focus Areas

Focus areas are suggested groupings of electives based on student interest. Students do not need to take all electives within one focus area; they are free to choose their 18-unit elective minimum from any combination of focus areas.

- Health Management/Administration Focus

- Health Policy Focus

- Health Analytic & IT Focus

Bachelor of Science in Music and Technology

The Bachelor of Science in Music and Technology is offered jointly by the School of Music, the School of Computer Science, and the College of Engineering.

This program consists of a set of courses that span both music and technology, as well as a capstone composition/design/performance project. Courses in all three areas of study are stipulated in the music and technology undergraduate curriculum and provide for students coming from any of the three areas. In other words, regardless of a student’s entry point — an interest in computer science, electrical engineering, or music — the coursework prescribed will allow the student to gain the requisite knowledge and experience in all three areas. Students will work closely with advisors and will be guided in both course selection and capstone projects.

Curriculum

Minimum units required for B.S. in Music and Technology 380

General Requirements 85 units

Seminar

- 57-570 Sound and Music Computing Seminar (8 semesters for a total of 8 units) 1
Students complete either the Music Concentration or the Technical Concentration:

**Music Concentration**
- 57-5xx Studio (4 semesters)
- 57-4xx Major Ensemble (4 semesters)

**Technical Concentration**
- 21-127 Concepts of Mathematics
- 15/18-213 Introduction to Computer Systems

AND EITHER:
- 18-220 Electronic Devices and Analog Circuits
- 18-240 Structure and Design of Digital Systems
- 15-2xx/18-3xx Electives in ECE or CS or above

OR:
- 15-128 Freshman Immigration Course
- 15-210 Parallel and Sequential Data Structures and Algorithms
- 15-323 Computer Music Systems and Information Processing
- 15-2xx/18-3xx Electives in ECE or CS or above

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**Bachelor of Science in Neuroscience**

Veronica Hinman, Department Head, Biological Sciences

Michael Tarr, Department Head, Psychology

www.cmu.edu/ni

Neuroscience is an interdisciplinary field in which scientists from many backgrounds apply the tools of biology, cognitive science, psychology, chemistry, mathematics, statistics, computer science, and engineering to develop a comprehensive understanding of brain function at the level of molecules, neurons, brain circuits, cognitive brain modules, and behavior. Research in neuroscience across these disciplines has grown substantially in the past two decades, and a solid understanding of the physiological basis of many aspects of brain function both in health and disease has come along with this growth in research. Along with this comes an increasing need for students to begin careers in neuroscience and to be prepared to work on the problems in neuroscience and to bring new answers to the public and to patients. In order to be successful in developing new treatments and answering outstanding questions in the field, neuroscientists need to be conversant in many different levels of inquiry from neurobiology to computational neuroscience.

The Dietrich College of Humanities & Social Sciences and the Mellon College of Science have joined forces to establish an exciting interdisciplinary program leading to a Bachelor of Science in Neuroscience. The goal of this degree program is to provide an intensive interdisciplinary education to enable outstanding students to become leaders in identifying and solving tomorrow’s neuroscience problems using a variety of methods. The program’s interdisciplinary curriculum is designed for students to gain a fundamental understanding of brain function on many different levels and to begin to specialize within the broad field of Neuroscience. Students in Mellon College of Science or Dietrich College may have a primary major in Neuroscience in any of the three concentrations. Students from other colleges may have a second major in Neuroscience in any of the three concentrations, subject to double-counting restrictions.

A degree in neuroscience provides excellent preparation for medical school or other graduate programs in the health professions. These students are aided by the Carnegie Mellon Health Professions Program (HPP), an advisory and resource service for all Carnegie Mellon students who are considering careers in the health care field. (See the HPP (http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateoptions/#healthprofessionsprogram) section in this catalog or www.cmu.edu/hpp for more information.)

Students wishing to pursue the Neuroscience major through Dietrich College should contact Dr. Lori Holt (loriholt@cmu.edu). Students wishing to pursue the Neuroscience major through the Mellon College of Science should contact the Biological Sciences Undergraduate Programs Office (biolograd@andrew.cmu.edu). Students wishing to pursue an additional major in either the Neurobiology or Computational Neuroscience concentrations should contact the Biological Sciences Undergraduate Programs Office (biolograd@andrew.cmu.edu). Students wishing to pursue an additional major in the Cognitive Neuroscience concentration should contact Dr. Lori Holt (loriholt@cmu.edu).

Students who pursue this major will:
- Gain a broad understanding of Neuroscience at many different levels of analysis, including: cellular biology of the brain, brain systems, cognitive brain function, and computational brain modeling
- Gain an understanding of the sciences underlying Neuroscience, including: Biology, Chemistry, Computer Science, Cognition and Psychology, and other emerging areas
- Develop a comprehensive understanding of brain function in health and disease
• Be familiar with neuroanatomy & neurophysiology and their implications for nervous system function
• Be prepared for advanced study in neurobiology, cognitive neuroscience, and/or neural computation
• Be able to collaborate with Neuroscientists across a wide range of systems and levels of analysis
• Prepare for careers in Neuroscience related companies, Neuroscience research, and/or medicine
• Be prepared for specialization within subfields of Neuroscience given their concentration selection

Requirements for a B.S. in Neuroscience

All students must complete the following:

1. General Science Requirements (see section A)
2. Core Neuroscience Courses (see section B)
3. Requirements for one concentration (see sections C, D, or E)*
4. 18 additional relevant course units in their home concentration or other neuroscience areas (some examples listed in sections C, D, E, & F). At least 9 of these units must be at the 300-level or above.
5. Their home college’s General Education requirements
6. Free elective units to come to a total of 360 total course units

* Double-counting restrictions and additional majors & minors
• Students may not major in two concentrations.
• Students using Neuroscience as an additional major or who have an additional major or minor to Neuroscience may only double-count at most 3 courses between this and their other major or minor (this restriction does not apply to prerequisites, General Education Requirements, or the General Science Requirements – section A).
• Other majors and minors may have more stringent double-counting restrictions, please consult with your neuroscience advisors and with the advising staff for the relevant host department for the other majors/minors.

A. General Science Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>or 21-125</td>
<td>Calculus II for Biologists and Chemists</td>
<td>9</td>
</tr>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>or 03-151</td>
<td>Honors Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-201</td>
<td>Undergraduate Colloquium for Sophomores</td>
<td>1</td>
</tr>
<tr>
<td>03-220</td>
<td>Genetics</td>
<td>9</td>
</tr>
<tr>
<td>or 03-221</td>
<td>Genomes, Evolution, and Disease: Introduction to</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Quantitative Genetic Analysis</td>
<td></td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-207</td>
<td>Techniques in Quantitative Analysis</td>
<td>9-12</td>
</tr>
<tr>
<td>or 09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td>9</td>
</tr>
<tr>
<td>or 03-124</td>
<td>Modern Biology Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I 1</td>
<td>9</td>
</tr>
<tr>
<td>or 33-122</td>
<td>Physics II for Biological Sciences and Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>Students</td>
<td>Students</td>
<td>12</td>
</tr>
<tr>
<td>33-121</td>
<td>Physics I for Science Students</td>
<td></td>
</tr>
<tr>
<td>15-110</td>
<td>Principles of Computing 2</td>
<td>10-12</td>
</tr>
<tr>
<td>or 15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
<td></td>
</tr>
<tr>
<td>or 02-201</td>
<td>Programming for Scientists</td>
<td></td>
</tr>
<tr>
<td>36-200</td>
<td>Reasoning with Data 2</td>
<td>9</td>
</tr>
<tr>
<td>or 36-247</td>
<td>Statistics for Lab Sciences</td>
<td></td>
</tr>
<tr>
<td>or 36-217</td>
<td>Probability Theory and Random Processes</td>
<td></td>
</tr>
<tr>
<td>or 36-225</td>
<td>Introduction to Probability Theory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>108-113</td>
</tr>
</tbody>
</table>

1. Neurobiology concentration students are required to complete 09-217 & 09-207 or 09-221.
2. Computational Neuroscience concentration students are required to complete 21-122, 15-112, & 36-217

B. Core Neuroscience Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
<tr>
<td>or 03-161</td>
<td>Molecules to Mind</td>
<td></td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>or 85-213</td>
<td>Human Information Processing and Artificial Intelligence</td>
<td></td>
</tr>
<tr>
<td>03-362</td>
<td>Cellular Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-363</td>
<td>Systems Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>15-386</td>
<td>Neural Computation 3</td>
<td>9</td>
</tr>
</tbody>
</table>
or 85-419 | Introduction to Parallel Distributed Processing*  
or 02-319 | Genomics and Epigenetics of the Brain                     |       |
or 86-375 | Computational Perception                                   |       |
|             |                                                            | 45    |

* Computational Neuroscience concentration students are required to complete 15-386.

C. Neurobiology Concentration

Didactic Core: Students must complete all of the following* Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-231</td>
<td>Honors Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-320</td>
<td>Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

* Neurobiology concentration students must complete 09-217 & 09-207 or 09-221 in their General Science Requirements (section A, above)

Required laboratory, data analysis, & methodological courses Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-343</td>
<td>Experimental Techniques in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-346</td>
<td>Experimental Neuroscience</td>
<td>12</td>
</tr>
</tbody>
</table>
or 03-345 | Experimental Cell and Developmental Biology |       |
|             |                                       | 24    |

Electives in Neurobiology (minimum of 18 additional units)** Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-133</td>
<td>Neurobiology of Disease</td>
<td>9</td>
</tr>
<tr>
<td>03-250</td>
<td>Introduction to Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-364</td>
<td>Developmental Neuroscience</td>
<td>9</td>
</tr>
<tr>
<td>03-365</td>
<td>Neural Correlates of Learning and Memory</td>
<td>9</td>
</tr>
<tr>
<td>03-366</td>
<td>Biochemistry of the Brain</td>
<td>9</td>
</tr>
<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
<td>9</td>
</tr>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
<td>9</td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-208</td>
<td>Techniques for Organic Synthesis and Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>
or 09-222 | Laboratory II: Organic Synthesis and Analysis |       |
| 42-202      | Physiology                             | 9     |
| 42-203      | Biomedical Engineering Laboratory      | 9     |
|             | NOTE: VERY Limited Seating Available for 42-203 |       |
|             |                                       | 18    |

** At least 9 of these units must be 300 level or above

D. Cognitive Neuroscience Concentration

Didactic Core: Students must complete all of the following Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-102</td>
<td>Introduction to Psychology</td>
<td>9</td>
</tr>
<tr>
<td>36-309</td>
<td>Experimental Design for Behavioral &amp; Social Sciences</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

Required laboratory, data analysis, & methodological courses Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-310</td>
<td>Research Methods in Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-314</td>
<td>Cognitive Neuroscience Research Methods</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

Electives in Cognitive Neuroscience (minimum of 27 additional hours)** Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-221</td>
<td>Principles of Child Development</td>
<td>9</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-261</td>
<td>Abnormal Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-356</td>
<td>Music and Mind: The Cognitive Neuroscience of Sound</td>
<td>9</td>
</tr>
<tr>
<td>85-370</td>
<td>Perception</td>
<td>9</td>
</tr>
<tr>
<td>85-390</td>
<td>Human Memory</td>
<td>9</td>
</tr>
<tr>
<td>85-406</td>
<td>Autism: Psychological and Neuroscience Perspectives</td>
<td>9</td>
</tr>
<tr>
<td>85-408</td>
<td>Visual Cognition</td>
<td>9</td>
</tr>
<tr>
<td>85-412</td>
<td>Cognitive Modeling</td>
<td>9</td>
</tr>
<tr>
<td>85-414</td>
<td>Cognitive Neuropsychology</td>
<td>9</td>
</tr>
</tbody>
</table>
or 85-419 | Introduction to Parallel Distributed Processing*  
or 85-424 | Hemispheric Specialization: Why, How and What? |       |
|             |                                       | 24    |
E. Computational Neuroscience Concentration

Didactic Core. Students must complete all of the following* Units
21-127 Concepts of Mathematics 10
15-122 Principles of Imperative Computation 10
or 15-150 Principles of Functional Programming
21-241 Matrices and Linear Transformations 10
or 21-240 Matrix Algebra with Applications 30

* Computational Neuroscience concentration students must complete 21-122, 15-112, and 36-217 in their General Science Requirements (section A, above) and 15-381 in their Core Neuroscience Courses (section B, above). Students must complete a minimum of 60 units in this concentration. Students should select their required laboratory and elective courses to complete a minimum of 31 units (four 9 unit courses or a lesser number of 9 and 12 unit courses could be combined to complete this requirement).

Required laboratory, data analysis, and methodological courses Units (18-24 total units)
42-631 Neural Data Analysis 9
or 86-631 Neural Data Analysis
42-632 Neural Signal Processing 12
15-494 Cognitive Robotics: The Future of Robot Toys 12
15-883 Computational Models of Neural Systems 12

Electives in Computational Neuroscience (minimum of 9 units) Units
03-512 Computational Methods for Biological Modeling and Simulation 9
or 02-512 Computational Methods for Biological Modeling and Simulation
10-401 Introduction to Machine Learning (Undergrad) 12
or 10-401 Introduction to Machine Learning (Master’s)
15-381 Artificial Intelligence: Representation and Problem Solving 9
15-387 Computational Perception 9
15-451 Algorithm Design and Analysis 12
15-453 Formal Languages, Automata, and Computability 9
15-494 Cognitive Robotics: The Future of Robot Toys 12
15-883 Computational Models of Neural Systems 12
16-299 Introduction to Feedback Control Systems 12
16-311 Introduction to Robotics 12
21-228 Discrete Mathematics 9
or 15-251 Great Ideas in Theoretical Computer Science
21-259 Calculus in Three Dimensions 9
21-272 Introduction to Partial Differential Equations 9
21-341 Linear Algebra 9
36-208 Regression Analysis 9
36-226 Introduction to Statistical Inference 9
36-350 Statistical Computing 9
36-401 Modern Regression 9
36-462 Special Topics: Data Mining 9
42/86-631 Neural Data Analysis 9
42-632 Neural Signal Processing 12

F. Additional Neuroscience Electives

Students are required to take a minimum of 18 additional relevant course units in their home concentration or other neuroscience areas. Some examples are listed in sections C, D, E & F above as well as in the list below. At least 9 of these units must be at the 300-level or above.

NOTE: this list is not restrictive. Concentration advisors can approve additional elective courses that contribute to the student’s neuroscience education, subject to additional approval by the major steering committee.

Examples of Additional Electives relevant to major*
33-122 Physics II for Biological Sciences and Chemistry Students, unless used for Science Core (section A) 9
76-385 Introduction to Discourse Analysis 9
80-210 Logic and Proofs 9
80-211 Logic and Mathematical Inquiry 9
80-220 Philosophy of Science 9
80-254 Analytic Philosophy 9
80-270 Philosophy of Mind 9
80-280 Linguistic Analysis 9
80-314 Causal Discovery, Statistics, and Machine Learning 9

* Up to 9 units of applicable undergraduate research course work (e.g. 03-445 or 85-507/85-508) can count as a neuroscience elective (not towards a concentration). A maximum of 27 additional units can be counted as free electives.

Free Electives (depending on concentration & college) 51-61
TOTAL hours to degree 360

B.S. in Psychology & Biological Sciences

Veronica Hinman, Department Head, Biological Sciences
Michael Tarr, Department Head, Psychology

This major is intended to reflect the interdisciplinary nature of current research in the fields of biology and psychology, as well as the national trend in some professions to seek individuals broadly trained in both the social and natural sciences.

Note: Students entering from the Dietrich College of Humanities and Social Sciences will earn a Bachelor of Science in Psychology and Biological Sciences. Students in the Mellon College of Science will earn a Bachelor of Science in Biological Sciences and Psychology.

Depending on a student’s home college (DC or MCS), General Education (GenEd) requirements will be different. GenEd requirements for DC (http://coursescatalog.web.cmu.edu/dietrichcollegeofhumanitiesandsocialsciences/ #hampssgeneraleducationprogram160) and MCS (http://coursescatalog.web.cmu.edu/melloncollegeofscience) are found on their respective Catalog pages.

Degree Requirements:

Biological Sciences Units
03-151 Honors Modern Biology 10
or 03-121 Modern Biology
03-220 Genetics 9
or 03-221 Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis
03-231 Honors Biochemistry 9
03-320 Cell Biology 9
03-343 Experimental Techniques in Molecular Biology 12
03-411 Topics in Research 1
03-412 Topics in Research 1
03-xxx General Biology Elective 9
03-xxx Advanced Biological Elective 18

Total Biology units 78

1 Please see description and requirements for electives under the B.S. in Biological Sciences section of this Catalog.

Mathematics, Statistics, Physics and Computer Science Units
21-120 Differential and Integral Calculus 10
21-124 Calculus II for Biologists and Chemists 10
or 21-122 Integration and Approximation
36-247 Statistics for Lab Sciences 9
or 36-200 Reasoning with Data
36-309 Experimental Design for Behavioral & Social Sciences 9
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-121</td>
<td>Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>or 33-141</td>
<td>Physics I for Engineering Students</td>
<td></td>
</tr>
<tr>
<td>15-110</td>
<td>Principles of Computing</td>
<td>10-12</td>
</tr>
<tr>
<td>or 15-112</td>
<td>Fundamentals of Programming and Computer Science</td>
<td></td>
</tr>
<tr>
<td>or 02-201</td>
<td>Programming for Scientists</td>
<td></td>
</tr>
<tr>
<td>99-101</td>
<td>Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Science units: 63-65

2 MCS students must also complete 33-122 Physics II for Biological Sciences and Chemistry Students.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>or 09-219</td>
<td>Modern Organic Chemistry</td>
<td></td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>or 09-220</td>
<td>Modern Organic Chemistry II</td>
<td></td>
</tr>
<tr>
<td>09-207</td>
<td>Techniques in Quantitative Analysis</td>
<td>9-12</td>
</tr>
<tr>
<td>or 09-221</td>
<td>Laboratory I: Introduction to Chemical Analysis</td>
<td></td>
</tr>
<tr>
<td>09-208</td>
<td>Techniques for Organic Synthesis and Analysis</td>
<td>9-12</td>
</tr>
<tr>
<td>or 09-222</td>
<td>Laboratory II: Organic Synthesis and Analysis</td>
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</tr>
</tbody>
</table>

Total Chemistry units: 56-62

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-102</td>
<td>Introduction to Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
<tr>
<td>85-2xx</td>
<td>Survey Psychology Courses</td>
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</tr>
<tr>
<td>85-310</td>
<td>Research Methods in Cognitive Psychology</td>
<td>9</td>
</tr>
<tr>
<td>or 85-340</td>
<td>Research Methods in Social Psychology</td>
<td></td>
</tr>
<tr>
<td>or 85-320</td>
<td>Research Methods in Developmental Psychology</td>
<td></td>
</tr>
<tr>
<td>or 85-314</td>
<td>Cognitive Neuroscience Research Methods</td>
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<td>or 85-330</td>
<td>Analytic Research Methods</td>
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</tr>
<tr>
<td>85-3xx</td>
<td>Advanced Psychology Electives</td>
<td>18</td>
</tr>
</tbody>
</table>

Total Psychology units: 63

1 Excluding 85-261 Abnormal Psychology

Additional Advanced Elective: 9 units

(Choose one of the following courses)

- 85-3xx Advanced Psychology Elective: 9
- 03-3xx Advanced Biology Elective: 9

Additional Laboratory or Research Methods: 9-12 units

(Choose one of the following courses)

- 03-344 Experimental Biochemistry: 12
- 03-345 Experimental Cell and Developmental Biology: 12
- 03-346 Experimental Neuroscience: 12
- 85-310 Research Methods in Cognitive Psychology: 9
- 85-314 Cognitive Neuroscience Research Methods: 9
- 85-320 Research Methods in Developmental Psychology: 9
- Elective Units: 33-36
- MCS Nontechnical Breadth or DC General Education requirements: 36-48

Total Elective units: 69-84

Minimum number of units required for degree: 360