

BACHELOR OF ARTS (BA) DEGREE WITH A MAJOR IN COMPUTATIONAL AND APPLIED MATHEMATICS

Program Learning Outcomes for the BA Degree with a Major in Computational and Applied Mathematics

Upon completing the BA degree with a major in Computational and Applied Mathematics, students will be able to:

1. Apply fundamental mathematics to perform critical analysis of an abstracted version of a real world problem and to build a model that captures the problem's salient characteristics.
2. Design, implement, and debug a computer program to solve a computational problem.
3. Critically analyze a mathematical or computational problem, explore techniques to model and solve the problem, and use mathematical or computational methods to produce one or more solutions.
4. Interpret a model and its results and communicate the results effectively to non-experts both orally and in writing.

Requirements for the BA Degree with a Major in Computational and Applied Mathematics

For general university requirements, see [Graduation Requirements \(https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/\)](https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/). Students pursuing the BA degree with a major in Computational and Applied Mathematics must complete:

- A minimum of 17-18 courses (49-53 credit hours), depending on course selection, to satisfy major requirements.
- A minimum of 120 credit hours to satisfy degree requirements.
- A minimum of 13 courses (37 credit hours) taken at the 300-level or above.

The courses listed below satisfy the requirements for this major. In certain instances, courses not on this official list may be substituted upon approval of the major's academic advisor or, where applicable, the department's Director of Undergraduate Studies. (Course substitutions must be formally applied and entered into Degree Works by the major's Official Certifier (<https://registrar.rice.edu/facstaff/degreeworks/officialcertifier/>.) Students and their academic advisors should identify and clearly document the courses to be taken.

Summary

Code	Title	Credit Hours
Total Credit Hours Required for the Major in Computational and Applied Mathematics		49-53
Total Credit Hours Required for the BA Degree with a Major in Computational and Applied Mathematics		120

Degree Requirements

Code	Title	Credit Hours
Core Requirements		
Introductory Courses ¹		
CMOR 220	INTRODUCTION TO ENGINEERING COMPUTATION	3
Select 1 course from the following: ²		3
CMOR 302	MATRIX ANALYSIS	
CMOR 303	MATRIX ANALYSIS FOR DATA SCIENCE	
MATH 354	HONORS LINEAR ALGEBRA	
MATH 355	LINEAR ALGEBRA	
MATH 101	SINGLE VARIABLE CALCULUS I ³	3
or MATH 105	AP/OTH CREDIT IN CALCULUS I	
MATH 102	SINGLE VARIABLE CALCULUS II	3
or MATH 106	AP/OTH CREDIT IN CALCULUS II	
Select 1 from the following:		3-6
MATH 212	MULTIVARIABLE CALCULUS	
MATH 221	HONORS CALCULUS III	
& MATH 222	and HONORS CALCULUS IV	
Intermediate Courses ⁴		
CMOR 304	DIFFERENTIAL EQUATIONS IN SCIENCE AND ENGINEERING	3
CMOR 360	INTRODUCTION TO OPERATIONS RESEARCH AND OPTIMIZATION	3
Select 1 course from the following: ⁵		3
MATH 302	ELEMENTS OF ANALYSIS	
MATH 321	INTRODUCTION TO ANALYSIS I	
MATH 322	INTRODUCTION TO ANALYSIS II	
MATH 331	HONORS ANALYSIS	
Select 1 course from the following:		3-4
STAT 310 / ECON 307	PROBABILITY AND STATISTICS	
STAT 311	HONORS PROBABILITY AND MATHEMATICAL STATISTICS	
STAT 315 / DSCI 301	PROBABILITY AND STATISTICS FOR DATA SCIENCE	
STAT 418	PROBABILITY	
Advanced Courses ⁶		
CMOR 422	NUMERICAL ANALYSIS	3
CMOR 430	ITERATIVE METHODS FOR SYSTEMS OF EQUATIONS AND UNCONSTRAINED OPTIMIZATION	3
Design Project ⁷		
CMOR 492	SENIOR DESIGN PROJECT I	2
CMOR 493	SENIOR DESIGN PROJECT II	2
Elective Requirements ⁸		
Select 4 elective courses from department approved electives (see course list below) ⁸		12
Total Credit Hours Required for the Major in Computational and Applied Mathematics		49-53
Additional Credit Hours to Complete Degree Requirements		36-40

University Graduation Requirements (https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/)	31
Total Credit Hours	120

Footnotes and Additional Information

- * **Note:** University Graduation Requirements include 31 credit hours, comprised of Distribution Requirements (Groups I, II, and III), FWIS, and LPAP coursework. In some instances, courses satisfying FWIS or distribution requirements may additionally meet other requirements, such as the Analyzing Diversity (AD) requirement, or some of the student’s declared major, minor, or certificate requirements. Additional Credit Hours to Complete Degree Requirements include general electives, coursework completed as upper-level, residency (hours taken at Rice), and/or any other additional academic program requirements.
- 1 The Introductory Courses requirement is typically fulfilled during the student’s first two years.
- 2 Students may petition the Director of Undergraduate Studies to substitute MATH 354 for CMOR 302.
- 3 Students with prior experience with calculus may replace MATH 101 or MATH 105 with a 3-credit quantitative elective at the 200-level or above, as approved by a CMOR undergraduate advisor (this quantitative elective is in addition to the four electives required below). Entering students should enroll in the most advanced course commensurate with their background; advice is available from the CMOR department during Orientation Week.
- 4 The Intermediate Courses requirement is typically fulfilled by the end of the student’s third year.
- 5 Students who plan to pursue graduate studies in Computational and Applied Mathematics should take MATH 302 *and* MATH 321.
- 6 The Advanced Courses requirement is typically completed by the end of the student’s fourth year.
- 7 The Design Project requirement is typically fulfilled during the student’s fourth year.
- 8 To fulfill the remaining Computational and Applied Mathematics major requirements, students must complete 4 additional courses (12 credit hours) at the 300-level or above from department approved coursework (see course list below). At least 2 elective courses (6 credit hours) must be from the departmental (CMOR) course offerings and may not include CMOR 494, CMOR 495 or independent study courses (such as CMOR 490 or CMOR 491). Elective courses from other programs must be chosen from a list approved by the CMOR Undergraduate Committee. At least 2 elective courses (6 credit hours) must be at the 400-level or above. The elective courses completed must be taken for a minimum of 3 credit hours.

Elective Requirements

Code	Title	Credit Hours
CMOR 404	GRAPH THEORY	3
CMOR 405 / MATH 423	PARTIAL DIFFERENTIAL EQUATIONS I	3
CMOR 410	MODELING MATHEMATICAL PHYSICS	3
CMOR 415 / ELEC 488 / NEUR 415	THEORETICAL NEUROSCIENCE: FROM CELLS TO LEARNING SYSTEMS	3

CMOR 416 / ELEC 489 / NEUR 416	NEURAL COMPUTATION	3
CMOR 420	COMPUTATIONAL SCIENCE	3
CMOR 421	HIGH PERFORMANCE COMPUTING	3
CMOR 423 / CEVE 455	NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS	3
CMOR 435 / MATH 435	DYNAMICAL SYSTEMS	3
CMOR 442	LARGE-SCALE OPTIMIZATION	3
CMOR 446	GRAPH ALGORITHMS	3
CMOR 451	SIMULATION MODELING AND ANALYSIS	3
COMP 422	PARALLEL COMPUTING	4
COMP 441	LARGE-SCALE MACHINE LEARNING	3
COMP 522	MULTI-CORE COMPUTING	3
ELEC 478	INTRODUCTION TO MACHINE LEARNING	3
INDE 517	MATHEMATICAL OPTIMIZATION FOUNDATIONS OF DATA SCIENCE	3
INDE 577	DATA SCIENCE AND MACHINE LEARNING	3
MATH 322	INTRODUCTION TO ANALYSIS II	3
MATH 382	COMPUTATIONAL COMPLEX ANALYSIS	3
MATH 410	CALCULUS OF VARIATIONS	3
MATH 412	PROBABILITY THEORY	3
MATH 425	INTEGRATION THEORY	3
MATH 427	COMPLEX ANALYSIS	3
MATH 523	FUNCTIONAL ANALYSIS	3
MECH 420 / ELEC 436	FUNDAMENTALS OF CONTROL SYSTEMS	3
MECH 473	ADVANCED FLUID MECHANICS I	3
MECH 474	ADVANCED COMPUTATIONAL MECHANICS	3
STAT 418	PROBABILITY	3
STAT 541	MULTIVARIATE ANALYSIS	3

Policies for the BA Degree with a Major in Computational and Applied Mathematics
Program Restrictions and Exclusions

- Students pursuing the BA degree with a major in Computational and Applied Mathematics should be aware of the following program restrictions:
- As noted in Majors, Minors, and Certificates (https://ga.rice.edu/undergraduate-students/academic-opportunities/majors-minors-certificates/), students may not major and minor in the same subject.
 - Students pursuing the major in Computational and Applied Mathematics may not additionally declare the major in Operations Research.
 - Students pursuing the major in Computational and Applied Mathematics may not additionally declare the minor in Operations Research.

Transfer Credit

For Rice University's policy regarding transfer credit, see [Transfer Credit \(https://ga.rice.edu/undergraduate-students/academic-policies-procedures/transfer-credit/\)](https://ga.rice.edu/undergraduate-students/academic-policies-procedures/transfer-credit/). Some departments and programs have additional restrictions on transfer credit. Requests for transfer credit must be approved for Rice equivalency by the designated transfer credit advisor for the appropriate academic department offering the Rice equivalent course (corresponding to the subject code of the course content). The Office of Academic Advising maintains the university's official list of [transfer credit advisors \(https://oaa.rice.edu/advising-network/transfer-credit-advisors/\)](https://oaa.rice.edu/advising-network/transfer-credit-advisors/) on their website: <https://oaa.rice.edu>. Students are encouraged to meet with the applicable transfer credit advisor as well as their academic program director when considering transfer credit possibilities.

Additional Information

For additional information, please see the Computational Applied Mathematics and Operations Research website: <https://cmor.rice.edu/>.

Opportunities for the BA Degree with a Major in Computational and Applied Mathematics

Academic Honors

The university recognizes academic excellence achieved over an undergraduate's academic history at Rice. For information on university honors, please see [Latin Honors \(https://ga.rice.edu/undergraduate-students/honors-distinctions/university/\)](https://ga.rice.edu/undergraduate-students/honors-distinctions/university/) (*summa cum laude*, *magna cum laude*, and *cum laude*) and [Distinction in Research and Creative Work \(https://ga.rice.edu/undergraduate-students/honors-distinctions/university/\)](https://ga.rice.edu/undergraduate-students/honors-distinctions/university/). Some departments have department-specific Honors awards or designations.

Fifth-Year Master's Degree Option for Rice Undergraduate Students

In certain situations and with some terminal master's degree programs, Rice students have an option to pursue a master's degree by adding an additional fifth year to their four years of undergraduate studies.

Advanced Rice undergraduate students in good academic standing typically apply to the master's degree program during their junior or senior year. Upon acceptance, depending on course load, financial aid status, and other variables, they may then start taking some required courses of the master's degree program. A plan of study will need to be approved by the student's undergraduate major advisor and the master's degree program director.

As part of this option and opportunity, Rice undergraduate students:

- must complete the requirements for a bachelor's degree and the master's degree independently of each other (i.e. no course may be counted toward the fulfillment of both degrees).
- should be aware there could be financial aid implications if the conversion of undergraduate coursework to that of graduate level reduces their earned undergraduate credit for any semester below that of full-time status (12 credit hours).
- more information on this *Undergraduate - Graduate Concurrent Enrollment* opportunity, including specific information on the registration process can be found [here \(https://ga.rice.edu/\)](https://ga.rice.edu/)

[undergraduate-students/academic-opportunities/undergraduate-graduate-concurrent-enrollment/](https://ga.rice.edu/undergraduate-students/academic-opportunities/undergraduate-graduate-concurrent-enrollment/).

Rice undergraduate students completing studies in science and engineering may have the option to pursue the Master of Computational and Applied Mathematics (MCAAM) or the Master of Industrial Engineering (MIE) degree. For additional information, students should contact their undergraduate major advisor and the MCAAM/MIE program director.

Additional Information

For additional information, please see the Computational Applied Mathematics and Operations Research website: <https://cmor.rice.edu/>.