

HANDBOOK FOR
THE APPLIED AND COMPUTATIONAL
MATHEMATICS OPTION

Department of Mathematics

Virginia Polytechnic Institute and State University

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The **Applied and Computational Mathematics (ACM) Option** is one of four “tracks” toward a B.S. in Mathematics offered at Virginia Tech. (The other tracks are (1) the *Traditional Option*, (2) the *Mathematics Education Option*, and (3) the *Applied Discrete Mathematics Option*). The ACM program is designed to train students for successful entry into jobs in laboratories and industrial organizations, as well as to prepare students for graduate study in applied mathematics, mathematics, and the sciences.

The ACM option has four components, each of which plays a crucial role in the career of a working applied mathematician.

Area of Applications. One of the main components of the ACM program is the requirement that all students taking the option acquire a substantial knowledge in some area of applications. Each student will be required to make (with the help of his or her advisor) an *individual program of study*. The program will contain 12 credits in a single technical discipline (i.e. usually from a single department).

Scientific Computing. Since computational hardware has become faster, cheaper and more common, all applied mathematicians (especially those who work in laboratories and industry) must be well-versed in the techniques of scientific computing. Thus, students taking the ACM option will be trained in the skills necessary to analyze, employ, and evaluate large-scale algorithms for solving applied problems. This is accomplished through courses in programming, scientific computing and numerical analysis.

Technical Tools of Applied Mathematics. Applied mathematics employs a broad spectrum of techniques, methods and tools in attacking real-world problems. Students in the ACM program will develop skills in discrete mathematics, ordinary differential equations, partial differential equations, numerical analysis, and scientific computation.

Mathematical Rigor. Students in the ACM option will receive a firm background in rigorous mathematics through such courses as Calculus of Several Variables, Advanced Calculus, Linear Analysis, Applied Discrete Mathematics, and Numerical Analysis. Courses such as Partial Differential Equations and Scientific Computing will provide links between mathematical rigor and applied problems.

For additional information on the ACM option, you should contact William Greenberg (231-5296) or Terry Herdman (231-7667). For additional information concerning aspects that uniformly affect all four Mathematics undergraduate degree options, you should examine the “Handbook for Mathematics Majors” available in the Mathematics Office, 460 McBryde Hall. (These topics include scholarships, advising, University and Arts & Sciences Core Curriculum requirements, course content explanations, the Honors Program, dual majors, minors, the Cooperative Education Program, undergraduate activities, mathematics competitions, job placement and preparation for graduate school).

Requirements in Mathematics		Credits
1205-1206	Calculus	3,3
1114,1224	Elementary Linear Algebra and Vector Geometry	2,2
2214,2224	Elementary Differential Equations and Multivariable Calculus	3,3
3034 (or 3434)	Proofs (or Applied Discrete Mathematics)	3
3214	Calculus of Several Variables	3
3224	Advanced Calculus	3
4425-4426	Fourier Series and Partial Differential Equations	3,3
4445,4446	Introduction to Numerical Analysis	3,3
4414	Scientific Computing	3
3144	Linear Algebra	3
	Math Electives ¹	6

Requirements in Applied Areas

CS 1044 or Math 3414	Intro to Prog in C/Prog in C Applications Area Program ²	3 12
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College of Arts and Sciences Requirements³

	Area 1: Writing and Discourse	6
	Area 2: Ideas, Cultural Traditions and Values	6
	Area 3: Society and Human Behavior	6
	Area 4: Natural Sciences	8
	Area 6: Creativity and Aesthetic Experience	3
	Area 7: Critical Issues in a Global Context	3
Free electives ⁴		24/26
Total Credits		<hr/> 120

¹ The six hours of math electives must be chosen from Mathematics courses numbered between 4024 and 4454, with the following exceptions: (a) MATH 3124 can be used to satisfy three of the six hours requirements. (b) No more than 3 hours from MATH 4044, 4334, 4344 can be used to satisfy the six hour requirement.

² See attached description of applications area program of study.

³ See current Core Curriculum Handbook or Catalog.

⁴ A maximum of 60 hours in Mathematics is allowed to be counted toward the 120 credit total.

Applications Area Program of Study

One of the main components of the ACM program is the requirement that all students taking the option acquire a substantial knowledge in some area of applications. Thus, students will be required to take 12 hours of courses in a single applications area. Each student will be required to make (with the help of his or her advisor) an *individual program of study* proposing the twelve credits. This plan will be submitted for approval to the ACM advisor. The program will contain 12 credits in a single technical discipline (i.e. usually from a single department). A sample of programs suggested by the ACM organizing committee appears below.

Note: In the lists of courses below, we have not explicitly noted prerequisites that are included in the requirements of the ACM option or that are included within the individual list; a program of study can always be selected from each list using only required courses, noted prerequisites, and courses from the list.

Aerospace Engineering¹

ESM	2104	Statics
ESM	2204	Mechanics of deformable bodies
ESM	2304	Dynamics
AOE	3014	Aero/hydrodynamics
AOE	3024	Thin-walled structures
AOE	3034	Vehicle vibration and control
AOE	3104	Aircraft performance
AOE	3114	Compressible aerodynamics
ME	3134	Fundamentals of thermodynamics

Biology

Biol	2304	Plant Biology
Biol	2504	General zoology
Biol	3124	Cell physiology
Biol	3404	Introductory animal physiology
Biol	4004	Freshwater ecology

¹ EF 1005 is a prerequisite and EF 1006 is corequisite for ESM 1004.

Economics²

Econ	2005-2006	Principles of economics
Econ	3104	Microeconomic theory
Econ	3204	Macroeconomic theory
Econ	4304	Econometric methods
Econ	4414	Economic forecasting
Econ	4424	Theory of games & economic behavior
Econ	4924	Managerial economics

Electrical and Computer Engineering³

EE	2005-2006	Network analysis
EE	2204	Electronics I
EE	3054	Electrical theory
EE	3105-3106	Electromagnetic fields
EE	3204	Electronics II
EE	3714	Circuits, signals, & systems
EE	4134	Fiber optics & applications

Finance

ACIS	2004 or 2115	Survey of Accounting
Econ	2115-2116	Principles of Economics
FIN	3104	Introduction to Finance
FIN	4114	Investment Analysis and Equity Markets
FIN	4124	Interest Rates and Debt Markets
FIN	4144	International Financial Management
FIN	4164	Financial Derivatives I
FIN	4174	Financial Derivatives II

(Note: FIN 3104 is pre-requisite to all advanced courses in finance. Econ 2115-2116 is pre-requisite to FIN 4124. If these courses are not taken, students should contact the instructor before signing up for a particular course.)

² Stat 2004 or 3005 is a prerequisite for Econ 3304.

³ EF 1006 is a prerequisite for EE 2005.

Management Science and Information Technology

ACIS	1504	Intro. to business information systems
Msci	2405-2406	Quantitative methods
Msci	3424	Computer modeling & decision analysis
Msci	3434	Advanced management science

Operations Research

Stat	4705-6	Probability & statistics for engineers
ISE	2404	Deterministic operations research
ISE	2404	Deterministic Operations Research
ISE	3414	Probabilistic Operations Research
ISE	3424	Discrete Event Computer Simulation
ISE	3614	Intro to Human Factors Engineering
ISE	4404	Statistical Quality Control

Physics

Phys	2305-2306	Foundations of Physics
Phys	3304	Foundations of physics II
Phys	3355-3356	Intermediate mechanics
Phys	3405-3406	Intermediate electricity & magnetism
Phys	4404	Magnetics
Phys	4614	Optics
Phys	4714	Intro. to biophysics

Statistics

Stat	4105-4106	Theoretical statistics
Stat	4004	Methods of statistical computing
Stat	4204	Experimental designs
Stat	4214	Methods of regression analysis
Stat	4514	Contingency table analysis
Stat	4524	Sample survey methods
Stat	3104	Probability and Distributions
Stat	3005-3006	Statistical Methods
Stat	4705-4706	Probability and Statistics for Engineers
Stat	4604	Statistical Methods for Engineers

Sample Course Sequence

Freshman Year: 15 Hrs. Fall, 15 Hrs. Spring

Fall Semester

ENGL 1105 (3)
MATH 1205 (3)
MATH 1114 (2)
Core Area 4 (4)
Core Area 2 (3)

Spring Semester

ENGL 1106 (3)
MATH 1206 (3)
MATH 1224 (2)
Core Area 4 (4)
Core Area 3 (3)

Sophomore Year: 18 Hrs. Fall, 15 Hrs. Spring

MATH 2214 (3)
CS 1044 (3)
Core Area 3 (3)
Core Area 2 (3)
Free Electives (6)

MATH 2224 (3)
MATH 3034 (3)
Core Area 6 (3)
Free Electives (6)

Junior Year: 15 Hrs. Fall, 15 Hrs. Spring

MATH 3214 (3)
MATH 4425 (3)
Applications Area (3)
Free Elective (6)

MATH 3224 (3)
MATH 4426 (3)
Applications Area (3)
Free Elective (3)
Free Elective (3)

Senior Year: 15 Hrs. Fall, 12 Hrs. Spring

MATH 4445 (3)
MATH 4414 (3)
MATH Elective (3)
Applications Area (3)
Free Elective (3)

MATH 4446 (3)
MATH 3144 (3)
MATH Elective (3)
Applications Area (3)