HANDBOOK
FOR THE
APPLIED COMPUTATIONAL
MATHEMATICS OPTION

Department of Mathematics
Virginia Polytechnic Institute & State University

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THE APPLIED COMPUTATIONAL MATHEMATICS OPTION

The **Applied Computational Mathematics (ACM) Option** is one of the four options or paths toward a B.S. in Mathematics offered at Virginia Tech, the others being (1) the *Traditional Option*, (2) *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 their advisor) an *Applications Area Program*. This program will contain 12 credits in a single discipline, usually technical and always in an area to which the student can apply mathematics.

Scientific Computing. Since computational hardware has become faster, cheaper and more common, all applied mathematicians (especially those who work in laboratories) and 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 theory, methods and tools in attacking real-world problems. Students in the ACM program will develop skills in 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 courses such as Calculus of Several Variables, Advanced Calculus, Linear Algebra, 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 Serkan Gugercin (email: gugercin@vt.edu, phone: 231-6549). For information concerning aspects that uniformly affect all four Mathematics undergraduate degree options, you should examine the Handbook for All Math Majors (available on the math department advising website: https://www.math.vt.edu/advising). These topics include scholarships, advising, University and College of Science Curriculum for Liberal Education and Pathways 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
1225 – 1226	Calculus of a Single Variable	4, 4
2204	Multivariable Calculus	3
2114	Introduction to Linear Algebra	3
2214	Elementary Differential Equations	3
3034	Introduction to Proofs	3
3144	Linear Algebra	3
3214	Calculus of Several Variables	3
3224	Advanced Calculus	3
4425	Fourier Series & Partial Differential Eqns	3
4426 or CMDA 4604	Fourier Series or Topics in Math Modeling	3
4445 – 4446	Introduction to Numerical Analysis	3, 3
4414 or 4454	Scientific Computing or Appl Math Modeling	3
	Math Electives[1]	6

Requirements in Applied Areas

Math 1454, Math 3054, CS 1114[2], CS 1044[2], or CS 1064[2]	Intro Math Prob Solv, Prog for Math Intro Software Design, Intro Prog in C or Intro to Prog in Python	3
	Applications Area Program[3]	12

College of Science Requirements

Consult the appropriate ACM graduation checksheet for Pathways or Curriculum for Liberal Education (CLE) requirements.

Free electives: Hours needed to achieve 120 credit graduation requirement.
This will be approximately 25 hours.

Total Credits	120

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

[2] IMPORTANT: Programming prerequisite for MATH 4414: CS 2114 or MATH 3054. MATH 1454 is an allowable programming prerequisite substitution for MATH 4414. Any programming course will suffice as the programming prerequisite for MATH 4454.

[3] See next page.

Applications Area Program

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 their 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 at least 12 credits of coursework in a single discipline, usually technical and always in an area to which the student can apply mathematics. Some examples of applications areas and courses are listed below.

Note: A 12-credit program of study can be selected from each list, but these lists are simply examples; many other course plans are possible. Prerequisites have not been explicitly noted. Not all courses are offered every term. Students are advised to check the relevant Timetable of Classes to determine the availability of particular classes and prerequisites. Some of the courses listed below might be restricted by majors within that discipline and so, enrollment may require a waiver from the department offering the course. This waiver is decided upon by the offering department, not the Mathematics Department. Students should always consult with their advisor about their intended course plans.

Aerospace Engineering

ESM	2104	Statics
ESM	2204	Mechanics of Deformable Bodies
ESM	2304	Dynamics
AOE	3014	Fluid Dynamics for AOE
AOE	3034	System Dynamics and Control
AOE	3114	Aerodynamics & Compressibility
ME	3134	Fundamentals of Thermodynamics

Biology

BIOL	2304	Plant Biology
BIOL	2504	General Zoology
BIOL	3404	Introductory Animal Physiology
BIOL	4004	Freshwater Ecology

Computational Modeling and Data Analytics (CMDA)[1]

CMDA 2005-2006	Integrated Quantitative Sciences
or STAT 3005-3006	Statistical Methods
CMDA 3634	Computer Science Foundations for CMDA
CMDA 3654	Introductory Data Analytics and Visualization
CMDA 4654	Intermediate Data Analytics and Machine Learning
CMDA 4664	Computational Stochastic Modeling

[1] Consult with your advisor before taking any CMDA courses. A student can earn credit for at most one of MATH 2204 and CMDA 2005. A student can earn credit for at most one of MATH 2214 and CMDA 2006. Successfully completing CDMA 2005 + CMDA 2006 will count for 6 applications area credits (considered equivalent to taking STAT 3005 and STAT 3006) if a student may earn credit for these courses. CMDA 2005 will count as 3 credits toward the application area (considered equivalent to STAT 3005), if a student may earn credit for this course. Students can take STAT 3005-3006 instead of CMDA 2005-2006 as part of a CMDA applications area plan.

CS 2114 is a prerequisite for CMDA 3634. Check the timetable for other CMDA course prerequisites.

Economics

ECON	2005-2006	Principals of Economics
ECON	3104	Microeconomic Theory
ECON	3204	Macroeconomic Theory
ECON	4124	Growth and Development
ECON	4304	Econometric Methods
ECON	4424	Theory of Games and Economic Behavior

Electrical and Computer Engineering

ECE	2004	Electric Circuit Analysis
ECE	2204	Electronics
ECE	2504	Intro to Computer Engineering
ECE	2574	Data Structures and Algorithms
ECE	3054	Electrical Theory
ECE	3105 – 3106	Electromagnetic Fields
ECE	3204	Analog Electronics
ECE	4134	Photonics

Finance

ACIS	2115	Principles of Accounting
ECON	2005-2006	Principles of Economics
FIN	3104	Introduction to Finance
FIN	4144	International Financial Management

(Note: FIN 3104 is prerequisite to many advanced courses in finance.)

Business Information Technology

ACIS	1504	Intro to Business Analytics & Business Intelligence
BIT	2405-2406	Intro to Business Statistics, Analytics, and Modeling
BIT	3424	Intro to Business Analytics Modeling
BIT	3434	Advanced Modeling for Business Analytics
BIT	3444	Advanced Business Computing and Applications
BIT	4434	Computer Simulation in Business

Operations Research

STAT	4705-4706	Probability & Statistics for Engineers
ISE	2404	Deterministic Operations Research
ISE	3414	Probabilistic Operations Research
ISE	3424	Discrete-Event Computer Simulation
ISE	3614	Human Factors Engineering and Ergonomics
ISE	4404	Statistical Quality Control

Physics

PHYS	2305-2306	Foundations of Physics I
PHYS	3355-3356	Intermediate Mechanics
PHYS	3405-3406	Intermediate Electricity & Magnetism
PHYS	4614	Optics
PHYS	4714	Intro. To Biophysics

Statistics[2]

STAT 3005-3006	Statistical Methods
STAT 3104	Probability and Distributions
STAT 4004	Methods of Statistical Computing
STAT 4105-4106	Theoretical Statistics
STAT 4204	Experimental Designs
STAT 4214	Methods of Regression Analysis
STAT 4514	Contingency Table Analysis
STAT 4524	Sample Survey Methods
STAT 4604	Statistical Methods for Engineers
STAT 4705-4706	Probability and Statistics for Engineers

[2] Consult the Timetable of Classes, the Academic Catalog, and http://www.stat.vt.edu/academics/courses.html to check course duplications.