HANDBOOK
FOR THE
APPLIED COMPUTATIONAL
MATHEMATICS OPTION

Department of Mathematics
Virginia Polytechnic Institute & State University

Revised May 2020
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 his or her advisor) an Applications Area Program. The 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 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 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 “Math Major Handbook” available in the Mathematics Office, 460 McBryde Hall and on the math department advising webpage. 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1225 – 1226</td>
<td>Calculus of a Single Variable</td>
<td>4, 4</td>
</tr>
<tr>
<td>2204</td>
<td>Multivariable Calculus</td>
<td>3</td>
</tr>
<tr>
<td>2114</td>
<td>Introduction to Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>2214</td>
<td>Elementary Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>3034</td>
<td>Proofs</td>
<td>3</td>
</tr>
<tr>
<td>3144</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>3214</td>
<td>Calculus of Several Variables</td>
<td>3</td>
</tr>
<tr>
<td>3224</td>
<td>Advanced Calculus</td>
<td>3</td>
</tr>
<tr>
<td>4425 – 4426</td>
<td>Fourier Series and Partial Differential Equations</td>
<td>3, 3</td>
</tr>
<tr>
<td>4445 – 4446</td>
<td>Introduction to Numerical Analysis</td>
<td>3, 3</td>
</tr>
<tr>
<td>4414</td>
<td>Scientific Computing</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Math Electives¹</td>
<td>6</td>
</tr>
</tbody>
</table>

### Requirements in Applied Areas

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1454, Math 3054, CS 1114², CS 1044², or CS 1054²</td>
<td>Intro Math Prob Solv, Prog for Math, Intro Software Design, Intro Prog in C or Intro Prog in Java</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Applications Area Program³</td>
<td>12</td>
</tr>
</tbody>
</table>

### 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 4024 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: MATH 4414 is required for all ACM option students. A prerequisite for MATH 4414 is CS 2114 or MATH 3054. MATH 1454 is an allowable prerequisite substitution for MATH 4414.

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 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 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: 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. In addition, not all courses appearing on the course catalog will be available every term. You are advised to check the relevant Timetable of Classes to determine the availability of particular classes. 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.

Aerospace Engineering
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

Computational Modeling and Data Analytics (CMDA)\(^1\)
CMDA 2005-2006 Integrated Quantitative Sciences
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

\(^1\)CMDA 2005 + CMDA 2006 will count for 6 applications area credits (considered equivalent to taking STAT 3005 and STAT 3006). Taking only CMDA 2005 will count as 3 credits (considered equivalent to STAT 3005). CS 2114 is a prerequisite for CMDA 3634.
Economics
ECON 2005-2006 Princpals 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
ECON 4924 Managerial Economics

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

Finance
ACIS 2004 or Survey of Accounting
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 all advanced courses in finance.)

Business Information Technology
ACIS 1504 Intro. To Business Information Systems
BIT 2405-2406 Quantitative Methods
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 Intro to Human Factors Engineering
ISE 4404 Statistical Quality Control

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2 STAT 3005 is a prerequisite for ECON 4304
3 ENGE 1016 is a prerequisite for ECE 2004. ECE 2274 is a corequisite for ECE 2204. PHYS 2306 is a prerequisite for ECE 3054
4 STAT 4105 is a prerequisite for ISE 3614 and can be a prerequisite for STAT 4706. ENGE 2314 is a prerequisite for ISE 3414.
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\(^5\)
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

\(^5\) Go to http://www.stat.vt.edu/academics/courses.html to check course duplications.