Theory into Practice

The Addition of Theoretical Math Courses to an Applied Curriculum

Terry J. Bridgman
Overview

- Who are we?
- What did we do?
- What do we still need to do?
Colorado School of Mines

- Located in Golden, Colorado
- A public research university devoted to engineering and applied science
- Student body of approximately 4400
- Highest admissions standards of any public university in Colorado
Department of Mathematical & Computer Sciences (MCS)

• 22 Academic Faculty Members
• 226 Undergraduates, 60 Graduates
• Areas of Concentration
  – Applied Statistics
  – Computational Mathematics
  – Computer Science
• Offering B.S., M.S. and Ph.D in Mathematical Sciences with options of Computational Mathematics, Applied Statistics or Computer Science
MCS Department

- Supports instruction of the core curriculum
  - 12 Semester hours of Calculus
  - 3 Semester hours of Differential Equations

- Supports instruction for requirements of majors in Engineering, Geophysics and Physics
  - 3 Semester hours of Linear Algebra
Curriculum Objectives

• The calculus sequence emphasizes mathematics applied to problems students are likely to see in other areas

• Priorities include:
  – Applied problems in the math courses; and
  – Ready utilization of math in the science and engineering courses
## Course Reqs. For Math Major, 2005-06

<table>
<thead>
<tr>
<th>Year</th>
<th>Courses</th>
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<tbody>
<tr>
<td>Freshman</td>
<td>Calculus I</td>
<td>Calculus II</td>
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<tr>
<td>Sophomore</td>
<td>Calculus III</td>
<td>Data Structures</td>
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<td></td>
<td>Programming Concepts</td>
<td>Differential Equations</td>
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<td>Linear Algebra</td>
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<tr>
<td>Junior</td>
<td>Intro. to Probability</td>
<td>Intro. to Math Modeling</td>
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<td></td>
<td>Algebraic Structures</td>
<td>1 Math Elective</td>
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<td>1 Computing Elective</td>
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<td>Field Course</td>
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<tr>
<td>Senior</td>
<td>Real Analysis</td>
<td>Intro. to Scientific Computing</td>
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<td></td>
<td>Senior Seminar I</td>
<td>Senior Seminar II</td>
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<td></td>
<td>2 Math Electives</td>
<td>1 Math Elective</td>
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Course Specifics

• Algebraic Structures
  – Required of all MCS majors
  – Topics include:
    • Logic, Proofs
    • Set Theory
    • Combinatorics
    • Graph Theory
Course Specifics

• Field Session
  – Required of all MCS majors
  – Students work in groups of 3-4 on a “real world” problem in mathematics or computer science
  – Deliverables include a finished project with supporting documentation
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<td>Honors Linear Algebra</td>
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<td>Foundations of Mathematics</td>
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<td>Junior</td>
<td>Intro. to Probability</td>
<td>Complex Analysis</td>
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<td></td>
<td>Real Analysis</td>
<td>Abstract Algebra</td>
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<td>Intro. To Scientific Comp.</td>
<td>1 Math Elective</td>
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<tr>
<td>Senior</td>
<td>Math Biology</td>
<td>Parallel Scientific Computing</td>
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<td>Computer Graphics</td>
<td>Capstone Course</td>
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<td>PDEs</td>
<td>2 Math Elective</td>
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Course Specifics

• Foundations of Mathematics
  – Required of MCS math majors
  – Writing intensive
  – Topics include:
    • Logic, proof techniques
    • Reading & writing proofs
Areas of Concern

• Transition from Core Curriculum to Degree Requirements
  – Linear Algebra gives the first detailed or prolonged discussion on theorems and proofs
  – Linear Algebra also marks the transition of working among fellow engineers to working among fellow math majors
  – To ensure minimal impact to degree requirements, students are expected to declare during their sophomore year
Areas of Concern

• Department must attract and support math students interested in both applied and theoretic course work

• Foundations course should provide introduction to theoretical techniques and provide examples of use of mathematics in other degree fields
Future Directions

• Enhance the Foundations course
  – Introduce Mathematical software
  – Relate the theory of mathematics to applications in other degree fields

• Additional theoretical and applied math classes
Questions?