Undergraduate Research
as a Complement and Supplement to Coursework

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CARTHAGE COLLEGE

Setting: Carthage College

- Kenosha, WI

- about 2700 students

- graduates 20-30 math majors each year

- 8 tenure-track math faculty
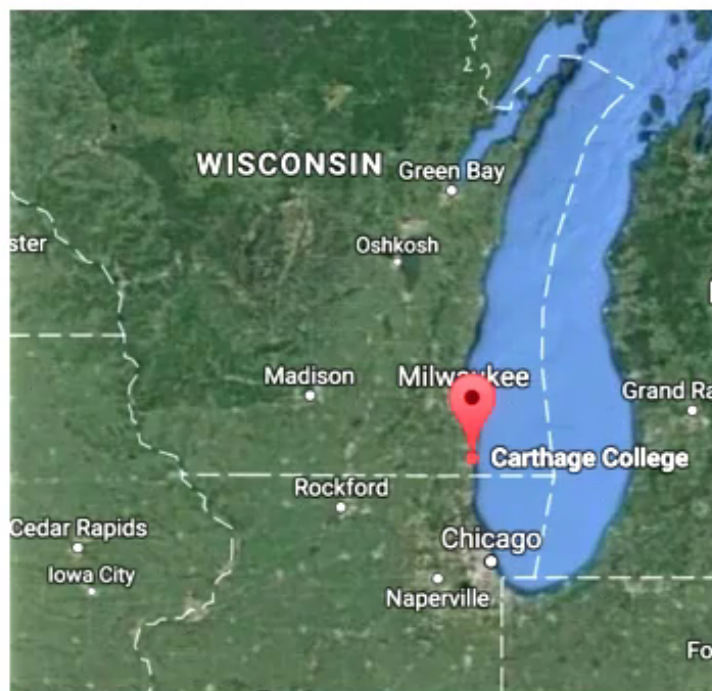
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Math major requirements

BA in Mathematics

- Core courses:
  - Calculus I & II
  - Intro Computer Science
  - Discrete Structures
  - Linear Algebra
  - Abstract Algebra
  - Real Analysis
  - Senior Thesis

- Three electives from:
  - Modern Geometry
  - Discrete Structures II
  - Teaching Mathematics
  - Abstract Algebra II
  - Intro Topology
  - Complex Variables
  - Actuarial Science
  - Theory of Statistics
  - Differential Equations
  - Multivariate Calculus
  - Math for Scientists and Engineers

Irregular scheduling

Compounding factors lead to gaps

- Student preparation
  - Many math majors take Calc 1 at Carthage
- No tracks/concentrations, few prerequisites
  - Wide open course selection process
- Small school
  - Small department
  - Limited course offerings
- Liberal arts
  - Significant general education requirements
  - Double-majors
  - Dual-degree program in engineering

Research opportunities

- Summer Undergraduate Research Experience (internal REU)

- Senior Thesis
  - required for all students
  - independent project
  - doesn't need to be "original"

Choosing research topics

❖ Default: choose topics that use students' strengths.

❖ Instead: focus on filling in missing pieces!

❖ Deciding what's "important"

   ❖ student weaknesses

   ❖ student maturity

   ❖ student interests

   ❖ career plans

Example 1: Actuarial models

- Senior thesis
- Interest in weather and actuarial science
- Supplement areas
    - Differential equations
    - Modeling
- Topic: geographic demographic shifts

Example 2: Engineering prep

- Senior thesis

- Pre-engineer (civil):
  - dual degree program: must condense required courses into three years

- Supplement areas
  - PDEs
  - Modeling
  - Computing & creating visualizations
- Topic: PDE model for bridge position due to loading

Example 3: Grad school prep

- Senior thesis

- Double-major in physics and math, interested in applied math grad school

- PDE experience from Math for Science and Engrs

- Interest in fluids but no background

- Topic: deriving model for and explicitly solving for velocity of 2D flow past a plate

Example 4: Complementing physics

- ❖ Senior thesis

- ❖ Double-major in physics and math

- ❖ Experience in Quantum Mechanics

- ❖ Physics thesis: Schrödinger eqn, numerical solutions to multiple-particle problem

- ❖ Topic: Schrödinger eqn
  - ❖ solving explicitly via separation and eigenfunctions
    - ❖ extending to higher dimensions
    - ❖ extending to other coordinate systems

Summary

- SLAC students may have gaps in knowledge.

- These gaps can be strategically filled using research projects.

- Coursework can be supplemented by choosing projects that require students to fill in the gaps.

- Non-math interests can be complemented using modeling, derivations, and other explorations.