Patrick T. Davis

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Education

PhD in Mathematics Central Michigan University (CMU)   December 2017

    Concentration: Teaching College Mathematics

    Qualifying Exams: Algebra, Analysis, Applied Mathematics

    Dissertation: *Delay Differential Equations in Epidemiological Modeling*

    Advisor: Dr. Thomas Gilsdorf, Professor

MA in Mathematics CMU   May 2017

    Qualifying Exams: Algebra and Analysis

BS Eastern Michigan University (EMU)   April 2011

    Majors: Mathematics, General Science

    Minor: Economics

    Recognitions: *summa cum laude*, University Honors, Department Honors

    Advisor: Dr. Andrew M. Ross, Associate Professor

Academic Positions

Mathematics Faculty   August 2018 – present
Illinois Mathematics & Science Academy (IMSA)
Full-time faculty member of the mathematics and computer science department. IMSA is a residential STEM-focused high school, created as an independent state agency. It accepts high-achieving students from across the state of IL and has a curriculum that spans from typical secondary school courses to those usually found at colleges and universities. Since March 2020, all instruction has been provided online as a result of the COVID-19 pandemic.

Accelerate Mathematics Instructor   August 2017 – June 2018
South Carolina Governor's School for Science & Mathematics (SC GSSM)
Full-time faculty member of the Accelerate virtual program – which provides an
engineering-focused curriculum to students across the state of South Carolina via an
online platform. Daily instruction is given in real-time via a video conferencing system.

Graduate Student Assistant   August 2011 – May 2017
Central Michigan University (CMU)
Full-time graduate student in the Department of Mathematics. Held teaching assis-
tantships, research assistantships, and doctoral fellowships at various times.

Teaching Experience

As a faculty member at the Illinois Mathematics & Science Academy:

AB Calculus I   F19, F20

The first in a two-course sequence designed to prepare students to take the AP Calculus
AB exam given by The College Board. The primary focus is differential calculus and
its applications.

AB Calculus II   S20

The follow-on course to AB Calculus I. The primary focus is integral calculus and its
applications.

BC Calculus I   F18, S19

This course is the first in a three-course sequence designed to prepare students to take
the AP Calculus BC exam given by The College Board. The primary focus is differential
calculus and its applications.

Differential Equations   S19, S20, S21

An introductory ordinary differential equations course, with an emphasis on mathemat-
ical modeling. Topics include analytic solutions, numerical solutions, and qualitative
analysis of linear ODEs, nonlinear ODEs, and systems of ODEs.

Mathematical Investigations IV   F19, F20

The final course in a precalculus sequence. Topics include sequences & series, trigonom-
etry, vectors, polar coordinates, and mathematical induction.

Multivariable Calculus   F18, S21

Vector calculus, as it would be covered in a standard university-level Calculus III course.
Topics include vectors, limits, differentiation, and integration – with a focus on three
dimensions but including extensions to n variables where applicable.

As faculty member at the South Carolina Governor's School for Science & Mathematics:

Honors Pre-Calculus   August 2017 – June 2018

This course is designed to prepare students to take the calculus series. Topics include polynomial functions, rational functions, exponential functions, logarithmic functions, and trigonometric functions.

Calculus BC   August 2017 – June 2018

This course is designed to prepare students to take the AP Calculus BC exam given by The College Board. Topics include most of the content from the standard university-level Calculus I and Calculus II courses (differential & integral calculus, infinite series, etc.).

As a graduate teaching assistant at Central Michigan University (and in addition to the teaching internships mentioned below):

Business Calculus (MTH 217)   Fall 2014, Spring 2014, Fall 2016

Differentiation and integration of algebraic, exponential, and logarithmic functions, applications of differentiation and integration, partial derivatives.
Independent Instructor. Course Coordinator: Dr. Leela Rakesh

Intermediate Algebra (MTH 105)   Fall 2012, Spring 2013

Algebraic expressions, functions, factoring, graphing, linear and quadratic equations, linear inequalities, systems of linear equations, rational expressions, radicals, negative and rational exponents. Successful completion of this course satisfies the University Mathematics Competency requirement.
Semi-Independent Instructor. Course Coordinator: Julia Burch

Teaching Internships

As part of the PhD program at CMU, students are required to complete two teaching internships – during which they serve as the independent instructor of an upper-level mathematics course under the mentorship of a faculty member. My teaching internships were in:

Differential Equations (MTH 334)   Fall 2015
Definition and solution of first, second, and higher order differential equations.
Mentor: Dr. Leela Rakesh

Linear Algebra & Matrix Theory (MTH 223)   Spring 2015
Systems of linear equations, matrices, determinants, vectors, vector spaces, eigenvalues, linear transformations, applications and numerical methods.
Mentor: Dr. Meera Mainkar

Research Interests

Topic Summary:

Mathematical Epidemiology. Delayed Differential Equations (DDEs). Dynamical Systems. Numerical analysis. Stochastic Modeling.

MSC2010 Classifications: 34C60, 34K, 37M, 92D25, 92D30

Dissertation Work:

- Instantaneous & Delayed Dispersal on Disease Dynamics in a Metapopulation
  Researched how standard epidemiological models may be adapted to reflect the spread of a disease through a metapopulation when movement between the subpopulations is delayed.
- Spatial Disease Dynamics
  Researched how infectious disease spreads through a population modeled in continuous space where there is some sort of embedded spatial population structure.

Possible Directions for Future Investigations:

- Cellular Automaton Models of Disease Spread
- Plant Epidemiology
- Numerical Algorithms for Solving Delayed Differential Equations
- Delayed Self-Quarantine Behavior in Epidemics
- Stochastic Delayed Differential Equations

Student Mentorship:

Currently overseeing two students on a self-directed research project through IMSA's Student Inquiry & Research program. They are learning how to model the spread of infectious disease. We started our investigations using an infuenza outbreak in a residential school setting as inspiration, but have since shifted directions to model the large-scale spread of COVID-19.

Selected Presentations & Posters

NCSSS Professional Converence (virtual)   Nov 2020
Supporting Our Struggling Students: Details of a Hybrid Mathematics Summer Bridge Program
Provided information about EXCEL2, a summer program developed at IMSA to address specific needs of students and to be adaptable each year as those needs change.
With Anita Connors White and Marti Shirley.

AMS Graduate Student Chapter (CMU)   Feb 2020
  Teaching at the High School Level: Specialized STEM Schools

Kane County Institute Day (Kaneland High School)   Mar 2019
  Create Pretty Documents with LaTeX!
  With Evan Brummet and Micah Fogel.

Mu Alpha Theta Induction Ceremony (IMSA)   Nov 2018
  The Mathematics of Disease: An Introduction to Compartmental Modeling

Student Seminar (Winthrop University)   Oct 2017
  The Mathematics of Disease: An Introduction to Compartmental Modeling

Graduate Student Seminar (CMU)   Sept 2016, Jan 2017
  A Practical Introduction to LaTeX

Joint Mathematics Meetings (Atlanta, GA)   Jan 2017
  Modeling an Infectious Disease in a Continuous Region with an Embedded Metapopulation
  Preliminary results on the spread of disease through a continuous region, using PDEs
  to model dispersal paths through a metapopulation. AMS Contributed Paper Session
  on Mathematical Biology, III.

Graduate Student Seminar (CMU)   Nov 2016
  Lessons from SMS: Infectious Disease Modeling
  Results from the 2016 SMS summer graduate school, Dynamics of Biological Systems.

MAA MathFest (Columbus, OH)   Aug 2016
  Using Python in an Introductory ODE Course
  Anecdotal evidence on incorporating Python projects in an undergraduate course on
  ordinary differential equations. Themed Contributed Session on Programming in Mathematics Classes and Mathematics for Programming.

SIAM Annual Meeting (Boston, MA)   Jul 2016
  A General Framework for the Analysis of Infectious Disease Models with Delayed Differential Equations
  General results on how to study infectious disease models making use of delay differential
  equations – including analysis of equilibria, stability, etc. Motivated by an example in
  metapopulations.

Student Research and Creative Endeavors Exhibition (SRCEE) (CMU) Apr 2015
  Wavelet Based Methods for Artifact Removal for Physiological Signals
  Analysis of electroencephalogram (EEG) signals using multiresolution analysis. Determined the optimal combination of wavelet type, thresholding rules, and decomposition
  level to best denoises the given contaminated biosignal data.
  With Oluremi Abayomi, Keshab Dahal, and Nonhle Channon Mdziniso. Faculty Advisor: Dr. En-Bing Lin

On Generalizing the Basic Reproduction Number ($\mathcal{R}_0$) for Delayed Infectious Disease Models
Studied previously formulated methods to determine the basic reproduction number of ODE systems, and then worked to understand simlar methods for systems of DDEs.
Faculty Advisor: Dr. Leela Rakesh

AMS Graduate Student Chapter (CMU)   Feb 2016
An Introduction to Stochastic Processes: Deriving Brownian Motion From Random Walk

Graduate Student Seminar (CMU)   Jan 2016, Sept 2015, Jan 2015, Sept 2014
A Practical Introduction to LaTeX
With Pin-Hung Kao.

Joint Mathematics Meetings (Seattle, WA)   Jan 2016
Effect of Delayed Dispersal in an Infectious Disease Model of a Large Metapopulation
Results similar to SRCEE 2015. AMS Session on Mathematical Biology and Related Fields.

Graduate Student Seminar (CMU)   Sept 2015
Lessons from MSRI: An Introduction to Systems Biology
Results from the MSRI 2015 summer graduate school, Mathematical Topics in Systems Biology.

AMS Graduate Student Chapter (CMU)   Sept 2015
The Mathematics of Disease: An Introduction to Compartmental Modeling
Motivation and analysis of the well-known Kermack-McKendrick (or SIR) model in which the population is divided into various compartments relating to the disease dynamics.

Student Research and Creative Endeavors Exhibition (SRCEE) (CMU) Apr 2015
Migration Delays in an Infectious Disease Model
Using DDEs to infectious disease in a metapopulation, where delays are caused by movement between the geographically (or otherwise) distinct subpopulations.
Faculty Advisor: Dr. Leela Rakesh

Application of a Fixed Point Method for Infectious Disease
Establishing the existence of a stable equilibrium point using a fixed point method on a system of integral equations based on the standard Kermack-McKendrick model for SIR dynamics.
With Mutaz Mohammad, Daniel Ntimoah, and Yifan Zhang. Faculty Advisor: Dr. En-Bing Lin

Graduate Student Seminar (CMU)   Nov 2014
An Introduction to Delay Differential Equations
Basic theory of DDEs with discrete delays, including the Method of Steps and key differences from ordinary differential equations.

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Student Research and Creative Endeavors Exhibition (SRCEE) (CMU) Apr 2014
  An Exploration of Delay Differential Equations
  Expository work examining various aspects of DDEs including the existence and uniqueness of solutions, the Method of Steps, and tactics for analyzing the delay.

SIAM Annual Meeting (San Diego, CA)   Jul 2013
  An Exploration of Dynamical Systems with an Application in Cancer Growth
  Results from 2013 SRCEE project.

Great Lakes SIAM Sectional Meeting (Mount Pleasant, MI)   Apr 2013
  An Exploration of Dynamical Systems with an Application in Cancer Growth
  Results from 2013 SRCEE project.

Student Research and Creative Endeavors Exhibition (SRCEE) (CMU) Apr 2013
  An Exploration of Dynamical Systems with an Application in Cancer Growth
  Using a system of differential equations to model the competition for nutrients between cancer cells and normal body cells.
  Faculty Advisor: Dr. Leela Rakesh

Joint Mathematics Meetings (Boston, MA)   Jan 2012
  Modeling the Spread of a Ug99-Type Wheat Pathogen in the United States of America
  Results from the 2012 URSP at EMU. AMS Session on Mathematical Biology and Related Fields, III.

Michigan MAA and MichMATYC Meeting (Ypsilanti, MI)   May 2011
  Modeling the Spread of a Wheat Pathogen in the United States
  Results from my Senior Honors Thesis.

Undergraduate Research Symposium (EMU)   Mar 2011
  Modeling the Effects of Cannibalistic Behavior in Zebra Mussel (Dreissena polymorpha) Populations
  Results from participation in the 2010 REU Program at TAMU.

  Modeling the Spread of a Wheat Pathogen in the United States
  Preliminary results from my Senior Honors Thesis.

Joint Mathematics Meetings (New Orleans, LA)   Jan 2011
  Modeling the Effects of Cannibalistic Behavior in Zebra Mussel (Dreissena polymorpha) Populations
  Results from participation in the 2010 REU Program at TAMU. AMS Session on Mathematical Biology and Ecology, IV.

MAA Undergraduate Mathematics Conference (Grand Rapids, MI)   Oct 2010
  Modeling the Effects of Cannibalistic Behavior in Zebra Mussel (Dreissena polymorpha) Populations
  Results from participation in the 2010 REU Program at TAMU.

Graduate Summer Schools

Séminaire de Mathématiques Supérieures (Edmonton, Canada)   May-Jun 2016
Dynamics of Biological Systems
Participated in the summer graduate school held at the University of Alberta. The program included lectures on biological waves/invasions, complex bio-networks, disease dynamics, multiscale biological dynamics, and the nonlinear dynamics of pattern formation.
Organizers: Dr. Mark Lewis, Dr. Thomas Hillen, and Dr. Yingfei Yi

Mathematical Sciences Research Institute (Berkeley, CA)   Jun-Jul 2015
Mathematical Topics in Systems Biology
Participated in the summer graduate school which explored the use of mathematics in biology through projects dealing with origin of mutation, cell polarity, lab image analysis, and determining causation.
Organizers: Dr. Steven Altschuler and Dr. Lani Wu

Undergraduate Research Experiences

Undergraduate Research Stimulus Program   May-Aug 2011
Modeling the Spread of a Wheat Pathogen in the United States of America
Furthered work done for my Senior Honors Thesis.
Faculty Sponsor: Dr. Andrew Ross.

Senior Honors Thesis   Aug 2010 – May 2011
Modeling the Spread of a Wheat Pathogen in the United States of America
Explored techniques to model the path of a hypothetical outbreak of a Ug99-variety stem rust in the United States of America and its effect on wheat production through a discrete deterministic model run via computer simulation. The model adapts a standard SEIR model for a single region of wheat and then extends it to consider the interactions between multiple regions, and finally throughout the entire country.
Advisor: Dr. Andrew Ross

COMAP Mathematical Contest in Modeling   Feb 2011
Say That Again? A Discussion of the Repeater Coordination Problem
Received an Honorable Mention ranking.
Collaborators: Shannon Bourke and Michael Ludke. Faculty Sponsor: Dr. Andrew Ross

Research Experiences for Undergraduates (REU)   Jun-Jul 2010
Modeling the Effects of Cannibalistic Behavior in Zebra Mussel (Dreissena polymorpha) Populations
Spent the summer doing an individual mathematical research project at Texas A&M University in College Station, TX on local zebra mussel population dynamics.
Advisors: Dr. Jay Walton and Dr. May Boggess

COMAP Mathematical Contest in Modeling   Feb 2010
Modeling the Sweet Spot of a Baseball Bat
Received a Meritorious ranking.
Collaborators: Donald Ellison and Xiaoai Chai. Faculty Sponsor: Dr. Andrew Ross

Professional Organizations

American Mathematical Society (AMS)   2010 – present

Illinois Council of Teachers of Mathematics (ICTM)   2018 – present

Mathematical Association of America (MAA)   2015 – 2018

National Council of Teachers of Mathematics (ICTM)   2020 – present

Society of Industrial and Applied Mathematics (SIAM)   2013 – 2020

The National Consortium of Secondary STEM Schools (NCSSS)   2017 – present

Mathematics-Related Student Organizations

AMS Graduate Student Chapter   Feb 2015 – May 2017
President (Aug 2015 – May 2017), Treasurer (Feb 2015 – Aug 2015)
Helped to found the student organization as Treasurer and then elected President for
the 2015-16 and 2016-17 school years. Organized regular meetings with talks on various
topics and ran social events. Collaborated with similar undergraduate student
organizations to run assorted events on campus.
Faculty Advisor: Dr. Meera Mainkar

Mathematics Club at EMU   Sept 2009 – Apr 2011
President (Jan 2010 – May 2011), Vice President (Sept 2009 – Jan 2010)
Helped to found the student organization as Vice President and went on to become the
President for the remainder of the academic year. Reelected to serve as President for the
2010-2011 school year. Worked closely with the Department of Mathematics to provide
a rounded experience on campus for students interested in the field of mathematics.

Selected Technical Skills

Course/Learning Management Systems   Highly proficient.
  At various times, I've used Blackboard, Google Classroom, Moodle, and Canvas.

Video Conferencing Platforms   Highly proficient.
  At various times, I've used Zoom, Google Meet, and Vidyo.

GeoGebra & Desmos   Highly proficient.
  Used during instruction for many courses.

HTML & CSS   Moderately proficient
  Used to create and maintain my personal website.

LaTeX   Highly proficient.
  Currently used on a daily basis as my primary document preparation system.

MATLAB   Highly proficient.
  Used for numerous completed projects.

Mathematica   Highly proficient.
  Used for numerous completed projects and with my Student Inquiry & Research students.

Python   Moderately proficient.
  Used during instruction of an ODE course and with my Student Inquiry & Research students.

Selected Service Activities

Colleague Support Team   Fall 2020

  Served on a teacher's faculty support group, as they completed the new teacher onboarding program at IMSA. Included making an informal evaluation of an online class session and reviewing their portfolio.

Faculty Professional Development   Fall 2020
  Canvas & HTML
  Offered a session for faculty members interested in learning how some HTML basics can be used to customize Pages in the Canvas learning management system, with emphasis on practical applications that could be directly integrated into their own course shells. With Namrata Pandya.

Transition Task Force   Summer 2020

One of two faculty representatives on the institution-wide committee to recommend policies and procedures for the transition to distance learning as a result of the COVID-19 pandemic. Helped to draft the Distance Learning Addendum to the Student Parent Handbook and the Fall 2020 Remote Working and Distance Learning Plan.

Canvas Transition Success Committee   Summer 2020

The sole faculty representative on the institution-wide committee to facilitate the adoption of the Canvas learning management system produced by Instructure. Co-leader for the faculty and students subgroup, helped to customize Instructure-provided trainings, and served as one of the faculty points-of-contact on the support tree.

ISBE Transitional Math Curriculum   Summer 2020

Part of IMSA's team to collect, vet, and develop activities for the STEM Pathway of the Illinois State Board of Education Transitional Math Curriculum.

Faculty Professional Development   Nov 2019
Google Classroom

Offered a hands-on session for faculty interested in exploring aspects of the Google Classroom course management system, including a lengthy question-and-answer portion. With Nadia Pierrehumbert and Tracy Townsend.

Zoom Pilot   Apr 2018

Piloted Zoom for SC GSSM, as the administration re-evaluated the Accelerate program's video conferencing platform. This included a demo for faculty and administration.

Physics Search Committee   Nov 2017 – Apr 2018

Served as a general member of the recommending committee in the hiring of a new Physics Instructor for the SCGSSM Accelerate program.

LaTeX Files   Jan 2016 – May 2017

Created a Beamer theme for Central Michigan University, managed a small team to create `cmuthesis.cls` file to properly format Masters Theses and doctoral dissertations at CMU, and put together `cmuposter.cls` to make CMU-themed academic/technical posters.

New Teaching Assistant Workshop   Aug 2014

Helped to facilitate discussions, presented on how to balance skills and concepts while using online homework, and provided feedback during mini-teaching sessions.

McNair Scholarship Program GRE Tutor   Summers from 2012-14

Organized and ran sessions to prepare the McNair Scholars at CMU to take the quantitative portion of the GRE.