Ricky Kurosawa

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RESEARCH INTERESTS

Geophysical and environmental fluid mechanics; mathematical modeling and numerical methods. Applications to energy and the built environment, including wind and wave energy, urban flows, and atmospheric and ocean modeling.

EDUCATION

Dartmouth College (Thayer School of Engineering) **Expected June 2027**
Master of Engineering in Mechanical Engineering
Bachelor of Engineering in Mechanical Engineering

Vassar College **May 2026**
Bachelor of Arts in Applied Mathematics
GPA: 3.90/4.00
- Departmental Honors

Five-year dual-degree program: Vassar 2022–24 and 2025–26, Dartmouth 2024–25 and 2026–27.

RESEARCH EXPERIENCE

Dartmouth College, Ice Fluid Dynamics Lab **June 2025 – Present**
Student Researcher (summer research assistant, 2025 and 2026) Supervisor: Prof. Colin R. Meyer

- Derived the governing equations for permafrost thaw from first principles using a mushy-layer continuum formulation, then developed a 1D finite volume solver that tracks Darcy velocity, temperature, and phase composition to identify the regimes that lead to a frozen steady-state profile.
- Nondimensionalized the governing equations to group behavior into dimensionless parameters such as Stefan and Péclet numbers; currently characterizing steady profiles in the high- and low-soil-fraction limits, with the low-fraction limit expected to recover sea-ice-like behavior.
- Validated the simulation against the analytical steady-state temperature profile in the limit of negligible latent heat, achieving a normalized RMSE below 1%.

Vassar College, Mathematics and Statistics Department **September 2025 – Present**
Independent Research Supervisor: Prof. Andy Borum

- Formulated and analyzed an optimal control problem for n planar agents with $n+1$ controls (independent forward speeds and a shared turn rate), motivated by models of swarm behavior.
- Bypassed the inconclusive Pontryagin Maximum Principle test by reparameterizing the problem with a spatial independent variable, showing that a positive shared turn rate is sufficient for optimality.
- Reduced the dynamics for n agents to a simple pendulum equation and showed that initial energy above the saddle energy keeps the shared turn rate nonnegative, yielding a geometric optimality condition on the initial controls. Currently characterizing the time until the turn rate first reaches zero for trajectories starting below the saddle energy.

PUBLICATIONS

R. Kurosawa and C. R. Meyer, "A Mushy-Layer Approach to Permafrost Thaw," in preparation.

R. Kurosawa and A. Borum, "Optimal Collective Motion of Planar Multi-Agent Systems," in preparation.

PRESENTATIONS

Hudson River Undergraduate Mathematics Conference (HRUMC) **April 2026**
Talk: Optimal Collective Motion of Planar Multi-Agent Systems.

Dartmouth Undergraduate Research Poster Session **August 2025**
Poster: A Mushy-Layer Approach to Permafrost Thaw.

SELECTED COURSEWORK

Dartmouth College: Intermediate Fluid Mechanics, Geophysical Fluid Dynamics, Modern Control Theory, Post-Modern and Non-Linear Control, Mechanical Behavior of Materials, Fourier Transforms.
Vassar College: Nonlinear Differential Equations, Numerical Analysis, Control of Dynamical Systems, Geophysics, Complex Analysis, Real Analysis.

SELECTED PROJECTS

NASA RASC-AL Senior Capstone (Team of 17) **Sept. 2026 – Present**

- Design an integrated system for building and maintaining durable transit pathways on the Moon.
- Lead the resource-transfer subteam, modeling heat transfer, phase change, and pipe flow.

Qualitative Analysis of Nonlinear Systems **January 2026 – May 2026**

- **HKB model of bimanual coordination:** nondimensionalized the model to two parameters; found a subcritical pitchfork bifurcation in which anti-phase coordination loses stability, and saddle-node bifurcations marking the loss of phase locking when the two oscillators' natural frequencies differ.
- **FitzHugh–Nagumo neuron model:** derived conditions for saddle-node, pitchfork, and Hopf bifurcations; established limit-cycle existence with a trapping region and Poincaré–Bendixson; located a homoclinic bifurcation to three significant figures using phase portraits and ODE45.
- **Torque-driven rigid body:** verified conservation of angular momentum and energy and derived the torque conditions that preserve each; showed a drag-like torque dissipates energy and selects the maximum-inertia axis, and that state feedback on all three axes produces chaotic rotation, mapping the transition with an orbit diagram over the feedback gain.

Controlling and Simulating Dynamical Systems **September 2025 – December 2025**

- **Quadrotor landing with ground effect:** linearized about a near-floor hover and derived the stabilizing PD gain region from the closed-loop eigenvalues; achieved 100/100 successful landings across randomized trials, settling within 10% of the target height in ≈ 1.9 s on average.
- **Rigid-body intermediate axis:** showed rotation about the unactuated axis is uncontrollable; designed pole-placement feedback with two torques that stabilizes the unstable intermediate-axis spin, and numerically mapped its region of attraction.
- **Motor-driven arm with free joint:** designed pole-placement state feedback with reference tracking; adding integral action removed the steady-state error when following a piecewise reference swinging between $-\pi/4$ and $\pi/4$ radians.
- **Unpowered glider:** designed an LQR controller with a Kalman filter that estimates three unmeasured states (forward and vertical speed, pitch rate) from two sensed angles to maximize flight distance.
- **Two-wheeled balancing robot:** designed LQG control on a six-state model including lateral and heading error relative to a random road, with the filter estimating the unmeasured tilt rate; completed 50/50 random roads without crashing.

Dual-Box Retrieval Robot **January 2024 – August 2024**

- Modeled a 2D two-armed robot in MATLAB using Newton's method and cubic splines (94% grasp success); independently extended it to 7 degrees of freedom with a minimum-norm Newton method and traced the solution set with numerical continuation.

PCA Leaf Classifier **January 2024 – May 2024**

- Built a matrix-free PCA classifier in MATLAB using the power method, reaching 90% accuracy (27/30) on held-out leaf images across 10 species.

TEACHING AND WORK EXPERIENCE

Teaching Assistant, Dartmouth College **3 terms, 2025 – Present**

- **Lead TA, Systems (Fall 2026 – Present):** assign grading questions to the TA team, grade weekly homework for 70+ students, and hold 8 hours of homework help weekly.
- **Homework TA, Distributed Systems (Spring 2025):** graded homework for 60+ students and held weekly homework help hours.
- **Lab TA, Systems (Winter 2025):** assisted labs on impedance, system identification, and second-order dynamics for ∼30 students.

Dual-Degree Ambassador, Dartmouth College **September 2026 – Present**

- Plan events and host monthly information sessions connecting incoming dual-degree students with fifth-year students.

Tutor, Elite College Prep **June 2025 – August 2026**

- Tutored high school students 5–12 hours per week in SAT preparation and Calculus I.

Japanese Student Aide, Vassar College **Fall 2022 – Spring 2024**

- Graded weekly assignments for 30+ students, proctored ∼3 make-up exams per week, and tutored students needing extra support.

SKILLS

Software and Languages: MATLAB, LaTeX, Python, Mathematica, SolidWorks
Mathematical Methods: nondimensionalization and scaling analysis, linear stability and bifurcation analysis, finite volume methods, numerical continuation, optimal control

EXTRACURRICULAR ACTIVITIES

Math Majors Committee, Vassar College **September 2025 – May 2026**
Co-President

- Organized weekly social and academic events for the math major community and coordinated student presentation opportunities.

Varsity Swimming, Vassar College **September 2023 – March 2026**

- Trained 15+ hours per week at the varsity level; former school record holder in 200 & 400 medley relay; twice named Liberty League Rookie of the Week.