

Committee Member,

I aim to enroll at Colorado State University to become quantitatively literate. J. Liu's numerical approach to flow in porous media and P. D. Shipman's experience advising graduate research motivates this application. At CSU, I would design and implement numerical methods to model aquifers in the Pacific Northwest. Upon attainment of a master's degree, I plan to complete a Ph.D. and enter an ecological industry.

Here are two descriptions of my research interests.

Sediment Transport In Idaho's Treasure Valley, farmers use a network of reservoirs and canals to suspend and divert the Boise river. To understand how this irrigation regime sweeps up and transports material, I would model water's energy in flood irrigated fields. Constrained by agricultural machinery and topography, I would search for furrow patterns that minimize water's turbidity. As a related project, I would consider canal geometries that interrupt high-velocity flows.

Ground Water Contamination The Army's December decision to not grant an easement for the Dakota Access Pipeline encourages me to research contaminant diffusion. In contribution to an environmental impact statement, I would (i) model geomorphic stress on the pipeline and (ii) consider the effects of a leak in regions of stress. I imagine the first item, characterizing tension in surrounding media, to be accessible as an inverse problem. I would approach the second item, assessing diffusion from an uncertain source, with a modified finite element method.

I share two examples of my relevant research experience.

Galois Theory & Fuchsian Equations Following Michio Kuga's analysis of Fuchsian-type differential equations, I parameterized the solution space of the hypergeometric equation. For interesting cases, I found the monodromy representation at singular points. I presented my method, its history and a potential application to fluid flow at The College of Idaho's 2016 student research conference.

Igneous Dikes in Scotland Relying on N. L. Bowen's *The Evolution of the Igneous Rocks*, I modeled the cooling of plagioclase feldspar magma. I proposed that my geology abroad group in Scotland visit Glen Sligachan, a significant site for Bowen's field observations. On June 4th, noticing rough shards of buoyantly exposed olivine lodged within dense clusters of plagioclase crystals, we validated Bowen's hypothesis that molten plagioclase carried partially solidified mafic minerals into the crust.

Consider my candidacy for a teaching assistantship. I here summarize what has prepared me to teach.



Tutoring & Grading I tutored calculus students one-on-one and graded physics coursework. I guided small groups through problems in elementary electromagnetism. I heard out my peers in introductory topology and posed constructive questions. As a Heritage Scholar at The College of Idaho, I led discussions in colloquium. In seminar, I organized half-hour workshops on the logistic equation and the heat equation. I also delivered an hour presentation on epidemiological modeling.

Time Away from School Over the last year, I volunteered on a ranch outside of Stuttgart and worked at a refugee resettlement office in Houston. These experiences refined my teaching ability. For example, while I learned \LaTeX for mathematical exposition, with it, I have created bus guides and applications for indigent health-care. As a second example, while I was exposed to guided problem solving (G. Polya) and inquiry based learning (R. L. Moore) in college, I have applied these pedagogies across language barriers. I plan ahead, relax in person, and invite questions.

Presently, I am a fellow in the Texas Episcopal Service Corps and employed as a refugee medical care intern. I work on a small team to provide intensive case management for refugees with complex medical conditions during their first year in the United States. In this work, I help limited English proficiency clients navigate one of the nation's densest health-care bureaucracies, I coordinate health plans to ensure coverage of medical services, and I accompany clients to safety nets (e.g., shelters and food pantries) in emergency situations.

I am confident that I would contribute formidably to your program. Thank you for your consideration.

Respectfully,
Colton Grainger

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OBJECTIVE	To complete an M.S. in Applied and Computational Mathematics at CSU.	
EDUCATION	B.S. in Mathematics-Physics <i>The College of Idaho, Caldwell, ID</i> <ul style="list-style-type: none"> Senior Study: <i>Galois Theory for Differential Equations</i> Advised by Dr. Jonny Comes. 	May 2016 GPA: 3.49
RESEARCH INTERESTS	<i>Multiscale Analysis and Computation</i> to approach complex systems (e.g., aquifers). <i>Numerical Methods</i> to model fluid flow and contaminant diffusion in porous media.	
EXPERIENCE	Refugee Medical Care Intern <i>YMCA International Services, Houston, TX</i> <ul style="list-style-type: none"> Managed 60 refugee medical cases in a team of 3 staff. Advocated for clients at clinics, food pantries and emergency shelters. Scheduled medical appointments, transportation and interpretation. 	August 2016 – Present
	Course Grader & Tutor <i>The College of Idaho</i> <ul style="list-style-type: none"> Graded weekly assignments for a section of 25 general physics students. Tutored 5 calculus students in weekly one-on-one sessions. 	September 2015 – December 2015
	Dishwasher & Server <i>The Griddle, Meridian, ID</i> <ul style="list-style-type: none"> Served food and kept clean a 100 m² commercial kitchen. 	Summers 2011 – 2013, Fall 2015
COMMUNITY INVOLVEMENT	Service Corps Fellow <i>Texas Episcopal Service Corps, Houston, TX</i> <ul style="list-style-type: none"> Lived in an intentional community with 2 other fellows. Committed to 1,700 hours of service in 11 months. 	August 2016 – Present
	WWOOF Ranch-Hand <i>Sonnwendhof Biofarm, Möckmühl, Deutschland</i> <ul style="list-style-type: none"> Built relationships with American, German and Italian WWOOFers. Pastured sheep and planted a sustainable garden. 	Summer 2016
SKILLS (rated out of 5)	<i>Languages</i> <ul style="list-style-type: none"> German (3), English (5) <i>Computer Algebra</i> <ul style="list-style-type: none"> SageMath (3), Mathematica (2) 	<i>Programming</i> <ul style="list-style-type: none"> Python (3), C++ (2) <i>Operating</i> <ul style="list-style-type: none"> GNU (3), macOS (4), Windows (4)
HONORS	Heritage Scholarship for academic merit Top Putnam Score among College of Idaho students Varsity Skier on The College of Idaho Ski Team	2012 – 2016 2013, 2015 2014, 2016

Undergraduate Syllabus^{*}

Colton Grainger

January 20, 2017

2015–2016

MAT-441 Topology

3 credit(s). Taught by Dave Rosoff, with final grade **A**.

- Dave Rosoff. *Course Notes on Elementary Topology*. Personally distributed, 2016. adapted from notes by Michael Starbird
- An introduction to the techniques and theorems of point-set topology. Approached in a modified Moore method, with emphasis on writing, revising and presenting proofs. Topics included cardinality, separation axioms, compactness, connectedness, continuity, as well as novel proofs for the Heine-Borel theorem and the fundamental theorem of algebra.

MAT-494 Galois Theory for Diff Eqs

2 credit(s). Advised by Jonny Comes, with final grade **A**.

- Michio Kuga. *Galois' Dream: Group Theory and Differential Equations: Group Theory and Differential Equations*. Birkhäuser Boston, 1993
- An independent study. Explored the correspondence between the fundamental group of the plane with n points removed and its covering surface. Used Galois theory to prune the ring of continuous functions (defined out of the covering surface) down to exactly those functions that were solutions to Fuchsian type differential equations.

PHY-330 Electricity & Magnetism

3 credit(s). Taught by James Dull, with final grade **A**.

- David Jeffery Griffiths. *Introduction to Electrodynamics*. Prentice Hall, third edition, 1999
- An intermediate level survey of classical electro-magnetic theory including electrostatic and magnetostatic fields and potentials, Gauss's law, Laplace's equation, dielectrics, vector potentials, magnetization and Maxwell's equations.

MAT-370 Geometry

3 credit(s). Taught by Jonny Comes, with final grade **A**.

- Michael P. Hitchman. *Geometry with an Introduction to Cosmic Topology*. Jones and Bartlett Publishers, 2009
- A preparation for Felix Klein's *Erlangen* program. Developed geometry in terms of a space and a group of transformations of that space. Emphasis on congruence relations. Topics included Möbius transformations, hyperbolic geometry and elliptical geometry and quotient spaces.

^{*}Courses are listed in reverse chronological order and grouped by academic year.

MAT-451 Real Analysis

3 credit(s). Taught by Jonny Comes, with final grade **A-**.

- Stephen Abbott. *Understanding Analysis*. Undergraduate Texts in Mathematics. Springer New York, 2015
- Proceeded from the Axiom of Completeness to rigorously prove results about the convergence of sequences and series. Defined continuity (Lipschitz and uniform), the derivative and nowhere differentiable functions. Used suprema and infima to define the Riemann integral.

MAT-498 Upper Division Seminar

1 credit(s). Taught by Dave Rosoff, with final grade **A**.

- Douglas R. Shier and K.T. Wallenius. *Applied Mathematical Modeling: A Multidisciplinary Approach*. Discrete Mathematics and Its Applications. CRC Press, 1999
- A student-led recitation concerned with computational methods for mathematical modeling. Considering the early outbreak of HIV in Houston as a case study, I presented a introduction to epidemiological modeling.

PHY-313 Thermal Physics

3 credit(s). Taught by James Dull, with final grade **A**.

- Daniel V. Schroeder. *An Introduction to Thermal Physics*. Addison Wesley, 2000
- Physical basis and applications of thermodynamics and statistical mechanics including temperature, heat engines, entropy and free energy. Included an introduction to Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics and their application to the solution of thermal, mechanical and electrical problems in fluids and solids.

2014–2015

MAT-431 Complex Variables

0 credit(s). Taught by Dave Rosoff.

- Matthias Beck, Gerald Marchesi, Dennis Pixton, and Lucas Sabalka. *A First Course in Complex Analysis*. Orthogonal Publishing L3c, 2014
- 5 weeks into Spring 2015, I administratively withdrew from all courses due to a health concern.

PHY-400 Quantum Physics

0 credit(s). Taught by Kathrine Devine.

- David Jeffery Griffiths. *Introduction to Quantum Mechanics*. Pearson international edition. Pearson Prentice Hall, 2005
- 5 weeks into Spring 2015, I administratively withdrew from all courses due to a health concern.

MAT-372 History of Mathematics

3 credit(s). Taught by Dave Rosoff, with final grade **B**.

- Carl B. Boyer and Uta C. Merzbach. *A History of Mathematics*. Wiley, 2011
- A historical survey of the ideas, tools, and symbols of mathematics and the people who developed them. Addressed sexagesimal computations, Diophantine equations, as well as medieval Indian analytic geometry. Emphasis on notation and legible proofs.

MAT-461 Algebraic Structures

3 credit(s). Taught by Robin Cruz, with final grade **B+**.

- David M. Clark. Theory of groups. *Journal of Inquiry Based Learning in Mathematics*, (No. 3), April 2007
- An inquiry based course in abstract algebra focused primarily on groups. Addressed basic properties, cyclic groups, LaGrange's Theorem, homomorphisms, isomorphisms, representation theorems, normal subgroups and quotient groups. Many examples.

MAT-498 Upper Division Seminar

1 credit(s). Taught by Dave Rosoff, with final grade **A**.

- Stanley J. Farlow. *Partial Differential Equations for Scientists and Engineers*. Dover books on advanced mathematics. Dover Publications, 1993
- A student-led recitation addressing partial differential equations in mathematical modeling. I presented an application of Fourier analysis to analytically solve the heat equation.

PHY-301 Theoretical Mechanics

3 credit(s). Taught by Kathrine Devine, with final grade **B+**.

- John Robert Taylor. *Classical Mechanics*. University Science Books, 2005
- A survey of classical and modern topics in dynamics. Topics included orbital mechanics, non-inertial reference frames, rigid-body motion, Lagrangian and Hamiltonian methods, and elements of nonlinear mechanics and chaos.

2013–2014

MAT-352 Differential Equations

3 credit(s). Taught by Dave Rosoff, with final grade **C+**.

- William E. Boyce and Richard C. DiPrima. *Elementary Differential Equations and Boundary Value Problems*. Wiley, ninth edition, 2008
- A study of the solution and applications of ordinary differential equations including systems of equations using matrix algebra.

MAT-361 Linear Algebra

3 credit(s). Taught by Robin Cruz, with final grade C.

- Robert A. Beezer. *A First Course in Linear Algebra*. Published Online, 2012
- A study of general vector spaces, linear transformations, eigenvalues and eigenvectors.

References

- [1] Dave Rosoff. *Course Notes on Elementary Topology*. Personally distributed, 2016. adapted from notes by Michael Starbird.
- [2] Michio Kuga. *Galois' Dream: Group Theory and Differential Equations: Group Theory and Differential Equations*. Birkhäuser Boston, 1993.
- [3] David Jeffery Griffiths. *Introduction to Electrodynamics*. Prentice Hall, third edition, 1999.
- [4] Michael P. Hitchman. *Geometry with an Introduction to Cosmic Topology*. Jones and Bartlett Publishers, 2009.
- [5] Stephen Abbott. *Understanding Analysis*. Undergraduate Texts in Mathematics. Springer New York, 2015.
- [6] Douglas R. Shier and K.T. Wallenius. *Applied Mathematical Modeling: A Multidisciplinary Approach*. Discrete Mathematics and Its Applications. CRC Press, 1999.
- [7] Daniel V. Schroeder. *An Introduction to Thermal Physics*. Addison Wesley, 2000.
- [8] Matthias Beck, Gerald Marchesi, Dennis Pixton, and Lucas Sabalka. *A First Course in Complex Analysis*. Orthogonal Publishing L3c, 2014.
- [9] David Jeffery Griffiths. *Introduction to Quantum Mechanics*. Pearson international edition. Pearson Prentice Hall, 2005.
- [10] Carl B. Boyer and Uta C. Merzbach. *A History of Mathematics*. Wiley, 2011.
- [11] David M. Clark. Theory of groups. *Journal of Inquiry Based Learning in Mathematics*, (No. 3), April 2007.
- [12] Stanley J. Farlow. *Partial Differential Equations for Scientists and Engineers*. Dover books on advanced mathematics. Dover Publications, 1993.
- [13] John Robert Taylor. *Classical Mechanics*. University Science Books, 2005.
- [14] William E. Boyce and Richard C. DiPrima. *Elementary Differential Equations and Boundary Value Problems*. Wiley, ninth edition, 2008.
- [15] Robert A. Beezer. *A First Course in Linear Algebra*. Published Online, 2012.