

CARY LAIRD BUTLER

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EDUCATION

University of Illinois at Urbana-Champaign (UIUC)

Urbana, IL

- Doctor of Philosophy in Mechanical Engineering
- Master of Science in Mechanical Engineering

Final defense February 6, 2024

May 2021

Adviser: Prof. Andrew Alleyne

Selected Coursework: Control Co-design (audited), Optimum control systems, Engineering Design Optimization

Auburn University

Auburn, AL

- Bachelor of Mechanical Engineering
 - Bachelor of Science in Physics
- Honors Scholar

May 2018

May 2018

ACADEMIC RESEARCH & PROJECTS

University of Illinois at Urbana-Champaign

Urbana, IL

Graduate Research Assistant

August 2018 – Present

- Developed control-oriented component models of electrical and thermal devices using graph-based techniques
- Integrated component models to develop computationally efficient dynamic models of electro-thermal systems
- Developed a framework for integrated plant and controller design of electro-thermal systems through multi-objective optimization
- Implemented model predictive control techniques in MATLAB/Simulink for online, optimal control of electro-thermal systems
- Developed a framework for rapid, robust planning of integrated power, propulsion, and thermal systems under non-convex, variable constraints
- Experimentally validated robust model predictive controller for energy management of hybrid-electric unmanned aerial vehicle (UAV) powertrain
- Multidisciplinary research collaborations in Center for Power Optimization of Electrothermal Systems (POETS)

Auburn University

Auburn, AL

Undergraduate Researcher

January 2016 – May 2018

- Designed, drafted, acquired, and assembled parts for powder-based additive manufacturing device
- Designed and 3D-printed simplified wind instrument prototypes to study chaotic phenomena in wind instruments

PROFESSIONAL EXPERIENCE

Air Force Research Laboratory (AFRL)

Wright-Patterson AFB, OH

Research Intern

May 2021 – August 2021

- Investigated set-based methods for modeling dynamics of a hybrid UAV powertrain
- Implemented set-based dynamic programming method for rapid, near-optimal control under non-convex constraints

MIT Lincoln Laboratory

Lexington, MA

Engineering Intern

May 2018 – August 2018

- Implemented multiple hypothesis testing algorithms to track dim targets in optical images
- Generated datasets with low signal-to-noise ratio for testing algorithm performance

Farley Nuclear Plant

Columbia, AL

Engineering Intern

May 2016 – August 2016

- Coordinated the completion and submittal of industry-relevant reports

PUBLICATIONS

- C. Butler, R. Smith, and A. G. Alleyne, "Sampling-based planning for guaranteed safe energy management of hybrid UAV powertrain under complex, uncertain constraints," (submitted to) *Transactions on Control Systems Technology*.
- C. Laird, Z. Kang, K. A. James, and A. G. Alleyne, "Framework for integrated plant and control optimization of electro-thermal systems: An energy storage system case study," *Energy*, vol. 258, p. 124855, Nov. 2022.
- C. Laird, "Modeling, Control, and Design of Hybrid Electrical and Thermal Energy Storage Systems," MS Thesis, University of Illinois at Urbana-Champaign, 2021.
- H.C. Pangborn, C. Laird, and A.G. Alleyne, "Hierarchical Hybrid MPC for Management of Distributed Phase Change Thermal Energy Storage Under Pulsed Loading," *Proc. of the 2020 American Control Conference*, July 2020.
- C. Laird, D. Docimo, C.T. Aksland, A.G. Alleyne, "Graph-Based Design and Control Optimization of a Hybrid Electrical Energy Storage System," *ASME Dynamic Systems and Control Conf.*, 2020. (Technical paper and presentation)

C. Laird and A.G. Alleyne, "A Hybrid Electro-Thermal Energy Storage System for High Ramp Rate Power Applications," *ASME Dynamic Systems and Control Conf.*, 2019. (Technical paper and presentation)

SELECTED PRESENTATIONS

Webinars

- C. L. Butler, A. Alleyne, "Online re-planning for energy management of a hybrid UAV powertrain under uncertainty," AFRL webinar, Feb. 2023.
- C. L. Butler, A. Alleyne, "Rapid, Assured Planning for Energy Management of a Hybrid UAV Powertrain," AFRL webinar, Oct. 2022.
- C. L. Butler, "Design and Operation of a Hybrid UAV Powertrain," Center for Power Optimization of Electro-Thermal Systems (POETS) Webinar, 2021.
- C. L. Butler, "Energy Primitives for Rapid, Assured Planning of a Hybrid UAV Powertrain," AFRL internship seminar, 2021.

Conferences

- C.L. Butler, A. Alleyne, "Rapid, robust re-planning for energy and thermal management of a hybrid UAV powertrain and thermal management system," Conference on Control Technology and Applications, 2023.
- C. L. Butler, et al, "Design and Control Optimization of Complex, Multi-Domain Systems-of-Systems for Improved Power Density," POETS Technical Conference, 2022.
- C. L. Butler, A. Alleyne, "Graph-Based Design and Control Optimization of a Hybrid Electro-Thermal Energy Storage System," Integrated Power, Propulsion, and Thermal Control Workshop, 2021.
- C. Laird, A. Alleyne, "Control of Energy Storage Systems for Pulsed Load Applications," AFRL Workforce Development Meeting, 2020.
- C. Laird, A. Alleyne, "Graph-Based Design Optimization of Hybrid Energy Storage Systems," POETS Technical Conference, 2020.

Poster & Pitch Presentations

- C. L. Butler, R. Smith, A. Alleyne, "Design and Control Optimization of Complex, Multi-Domain Systems-of-Systems for Improved Power Density," POETS Annual Meeting, 2022.
- C. L. Butler, A. Alleyne, "Graph-based modeling for design and control of electro-thermal systems," POETS Perfect Pitch Competition, POETS Annual Meeting, 2021.
- C. Laird, A. Alleyne, "Design and Control Optimization of Hybrid Thermal Energy Storage System," POETS Annual Meeting, 2020.
- C. Laird, A. Alleyne, "Modeling and Control of Electro-Thermal Hybrid Energy Storage Systems," POETS Annual Meeting, 2019.

LEADERSHIP

WYSE MechSE Camp Coordinator

Department of Mechanical Science and Engineering (MechSE), University of Illinois February 2023 – July 2023

- Assist MechSE staff to coordinate meetings, delegate roles, and organize supplies for week-long summer camp
- Train graduate student lab assistants on activities such as programming motors, building circuits, & 3D printing

President

POETS Student Leadership Council (SLC) August 2020 – July 2021

- Planned and oversaw meetings of the SLC, fostering communication between members from multiple disciplines and institutions
- Assisted center staff in programming and planning of student events during center-wide meetings
- Helped the SLC to craft long-term goals and seek creative ways to achieve them despite challenging circumstances

IT and Webinar Coordinator

POETS SLC August 2019 – July 2020

- Moderated bi-weekly webinars and uploaded webinar content
- Assisted center staff in managing website access and online content for center-wide meetings

Co-section Leader

Auburn University Marching Band August 2016 – January 2018

- With a fellow undergraduate student, led a section of 31+ piccolo players in daily warmups and stretches, weekly sectional rehearsals, and weekly gameday activities

Member Relations Officer

American Society of Mechanical Engineers, Auburn Student Chapter August 2016 – August 2017

- Organized student events, such as industry presentations and chapter meetings

Public Relations Committee Member

Engineers Without Borders, Auburn Student Chapter

August 2016 – January 2017

- Coordinated fundraising events and grant searches to raise funds for traveling students

PROPOSALS

Electric Vehicle Senior Design Project

POETS Education Seed Projects

June 2022

- Co-authored a successful proposal which was awarded \$10,000 to fund an educational project aiming to increase retention rates in vehicle electrification by sponsoring a senior design team

POETS COVID Wellness

National Science Foundation Engineering Research Center COVID Supplements

June 2021

- Authored a successful proposal which was awarded \$5,000 to provide mental health resources and related support for students in POETS

SKILLS

- Control co-design; electro-thermal-mechanical modeling; hardware-in-the-loop controller validation; model predictive control; state estimation
- Software: MATLAB/Simulink, SolidWorks, LabVIEW

HONORS, AWARDS, & SCHOLARSHIPS

List of Teachers Ranked as Excellent by Their Students

UIUC

Fall 2023

- Rated 4.9/5.0 in overall teaching effectiveness by students during teaching assistantship for ME461 (Computer Control of Mechanical Systems)

Future Technical Leaders Fellow

POETS

August 2021 – May 2022

- Completed one-year leadership program to pursue leadership positions at technology-focused companies
- Attended weekly webinars and completed assignments on topics such as leadership skills assessment, research commercialization, and writing technical white papers

SURGE Fellow

Grainger College of Engineering, University of Illinois

August 2018 – May 2023

- Awarded SURGE Fellowship, a 5-year fellowship program which aims to recognize outstanding incoming PhD students from historically underrepresented groups in engineering graduate programs

Dean's Medalist in Physics

College of Sciences and Mathematics, Auburn University

May 2018

- Outstanding graduating senior in the Physics department, nominated by faculty based on academic performance, character and potential

Dean's Award for Academic Excellence

College of Sciences and Mathematics, Auburn University

May 2018

- Awarded to graduating seniors with 4.0 GPA

O'Neal Austin Best Student Awards

Department of Mechanical Engineering, Auburn University

2016-2017

- Awarded to student earning the highest course grade in sophomore through senior-level mechanical engineering courses
- Received Best Student Awards in: System Dynamics and Controls (MECH3140), Fluid Mechanics (MECH3030), and Mechanics of Materials (MECH3130)

Alabama Space Grant Consortium Scholarship

Alabama Space Grant Scholarship

2017

- Awarded scholarship based on merit, recognizing high academic achievement and promise, from scholarship program supported by NASA and the State of Alabama

Tau Beta Pi Scholarship

Tau Beta Pi Engineering Honor Society

2017

- Awarded scholarship on the basis of academic achievement, extracurricular activities, and the promise of substantial contributions to the engineering profession

Carol C. Laster Band Scholarship

- Awarded scholarship to participate in Auburn University Symphonic/Concert Band as a non-music major

TEACHING, ADVISING, & OUTREACH EXPERIENCE

Teaching Assistant

ME 461, University of Illinois

August 2023 – December 2023

- Help students implement course concepts (pulse-width modulation, analog-to-digital conversion, serial communication protocols, basic implementations of embedded control) in hardware during weekly lab sessions
- Check student assignments and help students solve problems during weekly office hours

Independent Study Adviser

ME 497, University of Illinois

January 2023 – May 2023

- Defined course requirements and assignments for an undergraduate student's independent study
- Provided technical advice regarding system-level design and testing of an electric go-kart, including dynamic modeling, parts acquisition and integration, safety considerations, and test plans

Senior Design Project Co-adviser

ME 470, University of Illinois

August 2022 – December 2022

- Defined single-semester project scope and co-advised a team of four undergraduate students working on system-level design of an electric go-kart
- Provided technical advice and feedback on the team's presentations and reports

Lab Assistant

WYSE MechSE Summer Camp, University of Illinois

July 2022

- Joined a team of MechSE graduate students and staff in leading a week-long summer camp introducing high school students to mechanical engineering concepts

Outreach Committee Member

Graduate Society of Women Engineers, University of Illinois

August 2021 – August 2022

- Joined a team of multi-disciplinary women engineers in organizing and leading STEM outreach events for pre-school/elementary students at a local library

Fluid Mechanics Peer Tutor

Dept. of Mechanical Engineering, Auburn University

August 2017 – May 2018

- Led weekly group tutoring sessions in Fluid Mechanics (MECH3030) for 15+ junior/senior-level undergraduate mechanical engineering students
- Tailored lesson plans to address problem areas in students' comprehension as identified through regular meetings with course instructor

Calculus and Physics Peer Tutor

Study Partners, Auburn University

February 2016 – May 2017

- Led one-on-one, drop-in tutoring sessions for science and engineering students studying calculus and physics