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## EDUCATION

**Massachusetts Institute of Technology**, Cambridge, MA,

PhD, Electrical Engineering (MathWorks Fellow)

Advisor: Dr. Chathan Cooke

Thesis: A class of high-efficiency air-core power transformers with flux-guiding resonators

**Expected May 2024**

Research Area: High Power Electromagnetics

GPA: 4.90/5.00

**Massachusetts Institute of Technology**, Cambridge, MA,

SM, Electrical Engineering (Landsman Fellow, MathWorks Fellow)

Advisor: Dr. Chathan Cooke

Thesis: Design Methodology for an Ultra-High Efficiency Coreless Resonant Power Transformer

**May 2022**

Research Area: High Power Electromagnetics

GPA: 4.80/5.00

**University of Illinois at Urbana-Champaign**, Urbana, IL,

BS, Electrical Engineering

**May 2020**

GPA: 3.98/4.00

**Awards:** 2x MathWorks Fellowship; Landsman EE Fellowship; Robert C. MacCinchie Scholarship; Grainger Power Engineering; IEEE PES Scholarship; 2x Jules D. Falzer Memorial; Edward C. Jordan; Russell E. Berthold; Bronze Tablet

**Study Abroad:** National University of Singapore

**Fall 2018 Semester**

## EXPERIENCE

**Massachusetts Institute of Technology**, Cambridge, MA, *Graduate Research Assistant*

**September 2020-Present**

- AC loss reduction for a high efficiency, 40 kW air-core resonant power transformer (ProlecGE)
- Developed a versatile simulation-assisted layered mesh approach to modeling Litz wire in arbitrary configurations
- Created a high accuracy, fast analytical method for estimating losses in air-core, multi-phase coil systems
- Implemented a genetic-algorithm-based optimization for generating maximum efficiency designs of a class of coreless transformers with flux-guiding resonant coils, given desired power, frequency, input voltage, and voltage ratio.
- Developed an open-type balance calorimeter for high accuracy efficiency measurements of low loss devices. Direct calorimetric measurement of losses is impervious to harmonics in the electrical waveforms.
- Experimentally validated theoretical efficiency metrics and fully characterized prototype performance with VNA tools.

**Hinetics LLC**, Champaign, IL, *Director of Advanced Technologies*

**January 2020-Present**

- Proposed, negotiated, and secured more than \$11M of small business research grants
- Managing technical tasks and project deliverables for the largest award in ARPA-E's OPEN 2021 solicitation to develop a 10 MW partially superconducting motor for aircraft propulsion: achieving the world's highest specific power
  - Performs design tasks and leads the commercialization, certification, and T2M campaign.
- Managed a NASA Phase II SBIR project to manufacture and demonstrate a prototype motor for aircraft propulsion
- Leads transient electrical and thermal system modeling efforts for eVTOL load profile optimization (Air Force STTR)
  - Successfully proposed and leads Phase II for the build of transiently sized generator for eVTOL powertrains
- Wrote a successful NASA Phase I SBIR grant for a magnetics-embedded insulation and cooling architecture, PM
  - Successfully proposed Phase II and is managing the technical tasks for the design and build of two 150 kW generators for hybrid-electric genset integration.
- Wrote a successful NASA Phase II SBIR grant for the construction of two fully integrated gensets in the 150 kW-200 kW power range; one with the IO-360 ICE as prime-mover, and the other with a PBS Aerospace turboshaft.
- Developed a pole-pair test for an offshore wind turbine's actively shielded superconducting field coils (NSF Phase II)
- Generated an automatic machine sizing and optimization procedure for Hinetics' slotless, form-wound armature PMSM
- Designed a new coil mold for form-wound air-core windings with cured resin

**Ford Motor Company**, Chicago, IL, *Power Electronics R&D Intern*

**June-August 2020**

- Compared Wide Band Gap (WBG) Semiconductors with conventional Silicon IGBTs for traction inverter applications
- Developed a GUI to visualize performance over various operating biases and temperatures. This includes calculating parameters of interest from test data collected on power modules in Ford's inventory.

**Haran Research Group**, Urbana, IL, *Research Assistant*

**April 2019-May 2020**

- Performed multi-objective optimization for the design of superconducting machines for electric aircraft and wind turbine applications; preliminary work for NASA's LH<sub>2</sub>, fuel-cell powered commercial aircraft concept (CHEETA)

- Carried out EM FEA for a test rotor to measure ac losses in superconducting coils
- Aided in the development and application of ac loss models for superconducting machine windings
- Created a solid model to demonstrate the machine topology for a Pareto-optimal design

**Naval Surface Warfare Center, Crane, IN, SSEP Electrical Engineering Intern**

**May-August 2018**

- Performed cybersecurity research on vulnerabilities in the Ohio-class submarine's air-gapped fire control systems
- Detected and visualized a Funtenna based side-channel emanating from a monitor using an SDR
- Demonstrated practicality of parallel spectrum scanning for side-channel supervision and automatic detection with DSP
- Completed a project quoted for \$250,000 using a \$20 commercial SDR

## **PROJECTS AND LEADERSHIP EXPERIENCE**

**Illini Air Shuttle, President and Co-founder**

**September 2019-May 2020**

- Founded an RSO to develop an electric VTOL air shuttle concept for transportation between Champaign, IL and Chicago, IL; presented at AIAA EATS 2019
- Modeled a power system for safety analysis; includes dq motor control, power electronics, and machine parameters

## **CAMPUS INVOLVEMENT**

**Power and Energy Conference at Illinois (PECI), UIUC, Corporate Relations Co-chair**

**August 2019-May 2020**

**Eta Kappa Nu (HKN) Alpha Chapter, UIUC, Active Member**

**January 2018-May 2020**

**Electrical and Computer Engineering Department, Champaign, IL, ECE 385 UA**

**August 2019-May 2020**

**Electrical and Computer Engineering Department, Champaign, IL, ECE 210 Course Grader**

**January-May 2019**

## **SPECIALIZED SKILLS**

**Programs:** MATLAB, FEMM, COMSOL, Altair Flux, LTSpice, KiCad, Simulink, Autodesk Inventor, GOSSET

**Languages:** Mandarin (Intermediate)

## **JOURNAL PUBLICATIONS AND CONFERENCE PAPERS**

- **N. J. Salk** and C. M. Cooke, "Current Loop Approach to Computing Losses in Coaxial Multi-phase Air-core Coil Systems," in 2023 24<sup>th</sup> International Conference on the Computation of Electromagnetic Fields (COMPUMAG), 2023.
- D. Lee, **N. Salk**, T. Balachandran, P. Powell and K. Haran, "Integrated Magnetics, Insulation and Cooling Architecture for Slotless Electric Machines," 2023 IEEE Power and Energy Conference at Illinois (PECI), Champaign, IL, 2023.
- **N. J. Salk** and C. M. Cooke, "Calculation of AC Losses in Multi-phase Litz Coil Systems," in 2022 IEEE Transportation Electrification Conference & Expo (ITEC), 2022.
- S. Sirimanna, T. Balachandran, **N. Salk**, J. Xiao, and K. S. Haran, "Electric Propulsors for Zero-Emission Aircraft: Partially superconducting machines," in IEEE Electrification Magazine, 2022.
- D. Lee, T. Balachandran, S. Sirimanna, **N. Salk**, A. Yoon, P. Xiao, J. Macks, Y. Yu, S. Lin, J. Schuh, P. Powell, and K. S. Haran, "Detailed Design and Prototyping of a High Power Density Slotless PMSM," in IEEE Transactions on Industry Applications, 2022.
- T. Balachandran, **N. J. Salk**, D. Lee, M. D. Sumption, and K. S. Haran, "Methods of Estimating AC Losses in Superconducting MgB<sub>2</sub> Armature Windings with Spatial and Time Harmonics," in IEEE Transactions on Applied Superconductivity, 2022.
- **N. J. Salk** and C. M. Cooke, "A Versatile Simulation-Assisted Layered Mesh Analysis for Generalized Litz Wire Performance," in IEEE Transactions on Magnetics, vol. 58, no. 6, pp. 1-8, June 2022.
- D. Lee *et al.*, "Design and Prototype of a High Power Density Slotless PMSM for Direct Drive Aircraft Propulsion," 2021 IEEE Power and Energy Conference at Illinois (PECI), 2021
- T. Balachandran, D. Lee, **N. Salk**, J. Xiao, and K. S. Haran, "Evaluation and Mitigation of AC Losses in a Fully Superconducting Machine for Wind Turbine Applications," in IEEE Transactions on Applied Superconductivity, vol. 30, no. 4, pp. 1-5, June 2020
- T. Balachandran, D. Lee, **N. J. Salk**, and K. S. Haran, "A fully superconducting air-core machine for aircraft propulsion," IOP Conference Series: Materials Science and Engineering, Advances in Cryogenic Engineering: Proceedings of the Cryogenic Engineering Conference (CEC) 2019, June 2020
- J. Xiao, **N. Salk** and K. Haran, "Conceptual Design of an eVTOL Air Shuttle for Rapid Intercity Transport," 2020 IEEE Power and Energy Conference at Illinois (PECI), Champaign, IL, USA, 2020, pp. 1-8

## **PATENTS**

- (Pending) **N. Salk**, T. Balachandran, K. Haran, D. Lee, and P. Powell, "Slotless Electric Motor Having Improved Cooling," US Patent App. 17/661,819.