# Meghana Sudarshan

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**Objective:** *To utilize specialized knowledge in battery systems and machine learning to develop innovative energy storage solutions, facilitating the shift towards a cleaner and more sustainable future*

## Education

**Purdue University**: West Lafayette, IN, USA
**Ph.D. Candidate** *Expected Graduation: Aug 2025* *Aug 2021 – Present*
*Thesis: Prediction of Lithium-ion Battery Degradation with Machine Learning*

**Masters in Aeronautics and Astronautics** *Aug 2019 – Jul 2021*
*Thesis: Comparison of Likelihood of Hotspot Formation in Energetic Materials Due to Spherical and Planar Impact*

Relevant Courses: Neural Networks, Deep Learning, Rechargeable Batteries, Convex Optimization, Probability and Estimation, Data Science in Solid Mechanics, Uncertainty and Quantification, Multidisciplinary Design Optimization

**RV College of Engineering (RVCE)**: Bengaluru, India
**Bachelors in Aerospace Engineering** *Aug 2015 – May 2019*
*Thesis: Nature-Inspired Structures to Improve Crashworthiness*

## Technical & Professional Skills

**Programming**: Proficient in Python (Pandas, PyTorch, Flask, Scikit-learn, Matplotlib, TensorBoard, PyBamm), MATLAB, Fortran, Mathematica
**Software & Tools**: Battery Testers (Neware, Arbin), LiB Disassembly, EIS Spectroscopy, other engineering tools such as Abaqus, Ansys, Tecplot, and SolidWorks
**High-Performance Computing**: Skilled in running and optimizing SLURM jobs on HPC clusters for large-scale machine learning and simulation workloads.
**Data Science & Machine Learning**: Experienced in supervised learning, neural networks, time-series analysis, generative models, transformers, physics-informed neural networks (PINN), Docker, and AWS Cloud.
**Specializations**: Focused on predictive modeling, battery management systems, optimization techniques, API development, and time-series forecasting.
**Strategic Leadership & Collaboration**: Directed interdisciplinary research projects, spearheaded grant proposal writing, and managed patent processes. Held board positions in graduate organizations: Treasurer for AeroAssist and Graduate Researchers in International Development; Vice-President for Graduate Women in Aerospace.

## Experience

**Purdue University: Dept. of Aeronautics and Astronautics** West Lafayette, IN, USA
*Graduate Research Assistant - Dr. Vikas Tomar* *Spring 2021 - Present*
*PhD Researcher* — Machine Learning for Battery Informatics

- Designed, created, and developed an advanced neural network model, CD-Net, to predict the life cycle of lithium-ion batteries (LIB) in real-time for battery management systems (BMS). This model achieved a remarkable <2% error in predicting the remaining useful life (RUL) and improved accuracy by 12% across various battery chemistries. A bayesian variant of CD-Net is being adopted by *Primordis Inc.*
- Optimized battery health predictions using open-source cycling data by implementing advanced pre-processing techniques, reducing RMSE by 42.3% in state-of-health (SOH) predictions.
- Designed *DegradAI*, a scalable time-based AI framework that integrates cathode-chemistry identification with capacity fade modeling for accelerated degradation testing under specific operational conditions. The framework also produces synthetic battery data, enhancing model training and improving prediction accuracy by up to 22%.
- Currently engaged in research to create physics-informed machine learning models for predicting lithium-ion battery (LIB) capacity degradation in accidental scenarios, utilizing experimental cycling and failure databanks.

*Graduate Teaching Assistant & Graduate Mentor*

- Contributed to the design and development of the graduate-level course, Data Science for Solid Mechanics (DSSM). Delivered lectures and fulfilled GTA responsibilities for courses including *Computational Fracture Mechanics*, *DSSM*, and *Finite Element Analysis for Aerospace Structures.*
- Mentored four graduate students in integrating machine learning techniques into their research projects, covering diverse areas such as THz spectroscopy, battery informatics, cohesive finite element analysis on high-performance computing (HPC) systems, and aerodome ablation fracture characteristics.
- Supervised three undergraduates in the structural analysis of a propellant tank for Purdue's sounding rocket project, and two students in HPC applications utilizing FORTRAN.

## Internships

**And Battery Aero (ABA)** Palo Alto, CA, USA
*Assistant Member of Technical Staff - Dr. Shashank Sripad* *May – August 2024*

Optimized battery materials and protocols to meet energy-power demands for electric aircraft and conducted lifetime testing for high-energy, high-power batteries.

**Indian Institute of Science (IISc)** Bengaluru, India
*Summer Research Internship - Dr. Rajan Ganguli* *Summer 2018*

Interpreted inflow equation for helicopters as a closed form solution and higher-order Newton-Raphson method using symbolic computation in Python. Contributed to AIAA 2019 research paper.

## Awards & Professional Contributions

**Provisional Patents**: (Details withheld due to confidentiality)
1. Developed a novel method for onboard BMS battery degradation prediction. *Filed: Oct 2024*
2. Developed a system and method for real-time health monitoring of lithium-ion batteries in electric propulsion systems using advanced deep learning techniques. *Filed: Oct 2024*

**Awards**: Special Employee Recognition, Dept. of Aeronautics, Purdue (2024); ECS Travel Award, ECS 244 A07, Montreal (2023); Purdue PGSG Travel Award (2023); Graduate Student Travel Award, Purdue (2023)

**Scientific Journal Reviewer**: Served as a peer reviewer for *Energy*, *Nature Scientific Reports*, and *Ionics*

## Relevant Peer-Reviewed Journal Publications & Conference Presentations

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1. "DegradAI: Long-Term Capacity Degradation Prediction for Lithium-Ion Batteries Using Limited Cycling Data", *Journal of Energy Storage* (Submitted)
2. "In Operando Health Monitoring for Lithium-Ion Batteries in Electric Propulsion Using Deep Learning", *Batteries*, 10(10), 355, July 2024, DOI: 10.3390/batteries10100355
3. "A comparative analysis of the influence of data-processing on battery health prediction by two machine learning algorithms", *Journal of Energy Storage*, 10(10), 355, 2024, DOI:10.1016/j.est.2024.114524
4. "Data-Driven Autoencoder Neural Network for Onboard Battery Management System (BMS) Lithium-Ion Battery Degradation Prediction", *Journal of Energy Storage*, Volume 82, 110575, 2024, DOI: 10.1016/j.est.2024.110575
5. "Predicting the discharge capacity of a Lithium-ion battery after nail puncture using a Gaussian process regression with incremental capacity analysis", *Energy*, Volume 285, 129364, 2023, DOI: 10.1016/j.energy.2023.129364
6. "Direct measurement of internal temperatures of commercially available 18650 lithium-ion batteries", *Scientific Reports*, 13, 14421, 2023, DOI: 10.1038/s41598-023-41718-w
7. "Investigation of physical effects on prismatic lithium-ion cell electrodes after partial nail puncture using Raman spectroscopy and incremental capacity analysis", *eTransportation*, 12, 100174, DOI: 10.1016/j.etran.2022.100174
8. "Predicting Rapid Degradation Onset in Lithium-Ion Batteries during Real-Time Operation Using Machine Learning", *NASA Aerospace Battery Workshop*, Huntsville, AL, Nov 19-21, 2024
9. "Enhancing Temperature-Dependent Li-ion Battery Behavior Predictions with Transfer Learning", *244th ECS Meeting*, Sweden, 2023
10. "Data-Driven Prediction of Long- and Short-Term Li-ion Battery Degradation Using Public Datasets and Nail Puncture Testing", *NASA Battery Workshop*, 2022
11. "Prevention of Thermal Runaway in Li-ion Batteries Using Machine Learning Model Prediction", *TMS 150$^{th}$ Annual Meeting*, 2022
12. "Data-driven Model Based Comparison of Public Datasets for Online State of Charge Estimation in Lithium-Ion Batteries", *TMS 150$^{th}$ Annual Meeting*, 2022
13. "Use of Internal Temperature Sensors for Early Detection of Thermal Runaway in Large Capacity Lithium-Ion Pouch Cells", *NATAS*, 2021