Md Zesun Ahmed Mia

Curriculum Vitae

Curiosity drives me to seek new questions and create new knowledge. I believe progress in science comes from collaboration, open-mindedness, and the courage to explore beyond boundaries.

Education

08/2022–08/2027 (Expected) **Ph.D. in Electrical Engineering**, *Pennsylvania State University*, University Park, PA, USA, *CGPA: 4.00/4.00*
Advisor: Dr. Abhronil Sengupta

08/2022–08/2024 **M.S. in Electrical Engineering**, *Pennsylvania State University*, University Park, PA, USA, *CGPA: 4.00/4.00*
Thesis: Neuromorphic Computing for Lifelong Learning

02/2015–04/2019 **B.Sc. in Electrical and Electronic Engineering**, *Bangladesh University of Engineering & Technology (BUET)*, Dhaka, Bangladesh, *CGPA: 3.81/4.00*

Academic Research and Teaching Experience

08/2022–Present **Graduate Research Assistant**, *Penn State*, State College, PA
- Developed fabrication processes for and characterized spintronic devices; also performed electrical characterization of Ferroic devices (e.g.FeFETs, Hallbars) to extract key performance parameters.
- Engineered physics-based device models using TCAD (Silvaco/Sentaurus) and developed compact models in Verilog-A and MATLAB from characterization data for circuit simulation.
- Architecting a novel, high-performance ML accelerator tailored for Transformer-based workloads, focusing on hardware-software co-design principles.
- Pioneered a hardware-aware training framework to integrate fabricated spintronic devices into system-level designs, co-optimizing device physics and ML model performance.
- Investigated advanced neuromorphic and brain-inspired algorithms (e.g., Equilibrium Propagation, Astromorphic Transformer), evaluating their performance against traditional DNN/SNN models.
- Developed an adaptive Spike-Timing-Dependent Plasticity (STDP) learning rule for Dynamic Spiking Neural Networks (SNNs) to enable continual learning, with performance validated in cybersecurity threat detection scenarios.

08/2024–05/2025 **Graduate Teaching Assistant**, *Penn State*, State College, PA
- Taught Cadence Virtuoso (schematic/layout), PDK usage, DRC/LVS, and analog/digital design flows; created hands-on lab modules and guided tool/debug workflows.
- Supervised Capstone projects for 90+ undergraduate students across communications, electronics, and firmware: supported Raspberry Pi/Arduino development, software-defined radio experiments, PCB design, and system integration end-to-end.

02/2021–08/2022 **Lecturer**, *University of Liberal Arts Bangladesh*, Dhaka, Bangladesh
- Taught undergraduate courses: Solid State Devices, Digital Circuit Design, Semiconductor Device Physics, Power Electronics.
- Developed lab modules and supervised projects on semiconductor devices and circuits.
- Supervised student projects on semiconductor devices and circuits.

02/2020–02/2021 **Lecturer**, *BUET*, Dhaka, Bangladesh, part-time
- Supervised labs (Digital Circuit Design, Power Electronics).

Industrial Experience

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05/2025–07/2025 **Graduate Technical Intern**, *Intel Corporation*, Hillsboro, OR

- Designed and executed Design of Experiments (DOE) for exploratory thin film deposition projects, contributing to advanced technology node development.
- Investigated first-of-its-kind process integration tool for advanced technology node development, evaluating integration feasibility and process window optimization.
- Conducted comprehensive material characterization using DSIMS, XRR, stress analysis, and TEM image analysis to validate process performance and material properties.
- Developed predictive analysis framework using AI and machine learning to assess thin film deposition impact on semiconductor process flows and device characteristics.

09/2020–07/2021 **R&D Engineer**, *SEMWAVES Ltd.*, London, UK, part-time

- Delivered a 50 kW hybrid renewable system (solar + smallscale hydro) for an offgrid Bangladeshi site, supporting reliable community power.
- Owned technical leadership and coordination (vendors, field teams, stakeholders); directed device selection, integration, QA/safety procedures, and optimization against load profiles and uptime targets.

Technical Skills

Research	Neuromorphic Computing, ML, Device Physics, Circuits, Process Integration, Processing-in-Memory (PIM), near-memory computing, memory-centric computing, AI accelerator development, HPC applications, parallel computing architectures
Teaching	Course Design, Lecturing, Mentoring, Lab Supervision
Programming	Python, MATLAB, C++, Verilog, Shell
AI-Assisted Development	Advanced use of generative AI tools (Cursor, Copilot, VSCode) for research, teaching, and code development. Skilled in prompt engineering and integrating AI assistants into academic workflows.
Writing	Scientific Writing, Grant Proposals, Peer Review
EDA/Simulation	Cadence Virtuoso, Spectre, HSPICE, TCAD, COMSOL, ModelSim, Synopsys (Design Compiler, PrimeTime, VCS)
Data Analysis	Pandas, NumPy, JMP, Jupyter, Data Visualization (Matplotlib, Seaborn, Plotly), Statistical Analysis
Device/Process Characterization	AFM, SEM, Probe Station, Electrical Testing (DC/AC characterization, IV/CV measurements), TEM, reliability testing, parameter extraction
Collaboration	Git, Slack, Microsoft Office, Google Workspace

Research Interests

Neuromorphic Computing	Brain-inspired hardware, spiking neural networks (SNNs), event-driven sensing/compute, on-chip learning (STDP), crossbar synapses, oscillatory/phase-change/spintronic neurons, temporal coding, algorithm-device co-design, low-power edge intelligence
Machine Learning Hardware	DNN/GNN/Transformer accelerators, systolic and dataflow architectures, sparsity- and quantization-aware compute, mixed-signal MACs, compute-in-memory, near-memory compute, memory hierarchies, compilation and mapping, performance/energy modeling
Emerging Devices	Spintronics (STT/SOT-MRAM), FeFET/NCFET, RRAM/PCM memristors, 2D materials, analog programmability, endurance and variability
Semiconductor Process Integration	Device fabrication, FEOL/BEOL and BEOL-compatible memory, 3D monolithic integration, DTCO (design-technology co-optimization), compact modeling, variability and yield, process-device-circuit co-design
AI for Semiconductor	ML for process/device optimization, virtual metrology, yield prediction and defect classification, Bayesian optimization and surrogate modeling, inverse design, reinforcement learning for tool control

Research Projects

Astromorphic Transformer Lead Student Researcher, 2022–2025. Developed a bioplausible transformer architecture that uses neuron-astrocyte interactions to emulate self-attention mechanisms. Incorporated Hebbian and presynaptic plasticities with non-linearities and feedback, achieving improved accuracy and learning speed on sentiment classification, image classification, and language modeling tasks. See publication: [IEEE TCDS].

Spintronic Device-Based Memory Lead Student Researcher, 2023–Present. Led the fabrication and comprehensive characterization of spintronic memory arrays for machine learning systems, advancing non-volatile memory technologies to enhance computational performance.

Neuromorphic Cybersecurity Lead Student Researcher, 2023–2025. Developed a Hierarchical Dynamic Spiking Neural Network (D-SNN) for Network Intrusion Detection Systems (NIDS). The architecture employs a static SNN detector followed by an adaptive dynamic SNN classifier using GWR-inspired structural plasticity and a novel Adaptive STDP (Ad-STDP) learning rule. Demonstrated 85.3% overall accuracy on UNSW-NB15 benchmark in lifelong learning scenarios, mitigating catastrophic forgetting while adapting to new attack types. See publication: [arXiv], [ICONS 2025].

RMAAT: Bio-Inspired Sequence Processing Lead Student Researcher, 2024–Present. Developed RMAAT (Recurrent Memory Augmented Astromorphic Transformer), a recurrent transformer architecture for efficient long-context sequence processing. Employs segment-based processing with persistent memory tokens, adaptive compression via astrocyte-inspired retention factor, linear-complexity attention from astrocyte short-term plasticity, and AMRB (Astrocytic Memory Replay Backpropagation) training algorithm. Achieved competitive accuracy on Long Range Arena (LRA) benchmark with substantial computational and memory efficiency improvements. Under review at ICLR 2026. See publication: [OpenReview].

MIPS Microprocessor Design Lead Student Researcher, 2018–2019. Designed and implemented a 5-stage pipelined MIPS microprocessor in Verilog, supporting instruction/data memory, forwarding, and hazard detection. Verified functionality through simulation and synthesized for FPGA deployment.

ECG Rats Processor Lead Student Researcher, 2023. Developed a custom digital signal processing (DSP) processor, "ECG Rats," for real-time ECG signal analysis. Implemented core modules for filtering, feature extraction, and arrhythmia detection. Demonstrated on FPGA with live biomedical data.

IRFD: Electricity Fraud Detection First Author, 2021. Developed IRFD, a feature engineering-based ensemble classification method for detecting electricity fraud in traditional meters. Demonstrated improved detection accuracy on real-world meter datasets using advanced machine learning. See publication: [IEEE ICCIT 2021].

DCNN-LSTM Audio Classification Co-Author, 2022. Developed a DCNN-LSTM based audio classification system combining multiple feature engineering and data augmentation techniques. Achieved robust performance on diverse audio datasets. See publication: [ICO 2021, Springer].

2D Monolayer GaN Nanoribbons First Author, 2024. Investigated the impact of doping and defects on thermal transport of monolayer GaN nanoribbons using molecular dynamics simulation. Provided insights into nanoscale heat management for next-generation electronics. See publication: [ICECE 2024].

Ultra Low Cost Electronic Braille Device First Author, 2022–2024. Designed and implemented a solenoid-based electronic Braille device using 3D printing and Arduino microcontroller. The hexagonal-designed device weighs 338g, costs $20, employs PWM control for low power consumption, and connects via USB/Bluetooth to cellular devices and laptops. Achieved 100 frames/s refresh rate, enabling real-time text-to-braille translation for visually impaired users. See publication: [iCACCESS 2024].

Research Grants

NSF Award #2318101 Graduate Researcher, 2023–Present. **Neuromorphic Computing Hardware**: Supported research on neuromorphic hardware and algorithms for energy-efficient AI as part of an NSF-funded project. See award: [NSF 2318101].

NSF Award #2333881 — Graduate Researcher, 2024–Present. **Brain-Inspired AI for Edge Computing**: Contributed to NSF-funded research on brain-inspired AI and edge computing, focusing on neuromorphic models and hardware. See award: [NSF 2333881].

NSF Award #2028213 — Graduate Researcher, 2022. **AI Hardware for Scientific Discovery**: Participated in NSF-funded work on AI hardware and scientific applications, including device-circuit-algorithm co-design. See award: [NSF 2028213].

Publications

[1] Md Zesun Ahmed Mia, Malyaban Bal, and Abhronil Sengupta. "Delving deeper into astromorphic transformers". In: *IEEE Transactions on Cognitive and Developmental Systems* (2025).

[2] Md Zesun Ahmed Mia et al. "Neuromorphic Cybersecurity with Semi-supervised Lifelong Learning". In: *arXiv preprint arXiv:2508.04610* (2025).

[3] Md Zesun Ahmed Mia and Kazi Toukir Ahmed. "Ultra Low Cost, Low Power, High Speed Electronic Braille Device for Visually Impaired People". In: *2024 International Conference on Advances in Computing, Communication, Electrical, and Smart Systems (iCACCESS)*. IEEE. 2024, pp. 1–6.

[4] Md Zesun Ahmed Mia, Malyaban Bal, and Abhronil Sengupta. *RMAAT: A Bio-Inspired Approach for Efficient Long-Context Sequence Processing in Transformers*. 2024. URL: https://openreview.net/forum?id=ikSrEv8FId.

[5] Md Zesun Ahmed Mia et al. "Impact of Doping and Defects on Thermal Transport of Monolayer GaN Nanoribbons: A Molecular Dynamics Simulation Study". In: *2024 13th International Conference on Electrical and Computer Engineering (ICECE)*. IEEE. 2024, pp. 685–690.

[6] Tao Zhang et al. "Self-sensitizable neuromorphic device based on adaptive hydrogen gradient". In: *Matter* 7.5 (2024), pp. 1799–1816.

[7] KM Ashraful Hoque Fahim et al. "Study of 3-nm Cylindrical GAAFETs with Variations in High-k Dielectric Gate-oxide Materials". In: *2022 IEEE Symposium on Industrial Electronics & Applications (ISIEA)*. IEEE. 2022, pp. 1–5.

[8] Md Moinul Islam et al. "DCNN-LSTM based audio classification combining multiple feature engineering and data augmentation techniques". In: *Intelligent Computing & Optimization: Proceedings of the 4th International Conference on Intelligent Computing and Optimization 2021 (ICO2021) 3*. Springer. 2022, pp. 227–236.

[9] Md Zesun Ahmed Mia et al. "Irfd: A feature engineering based ensemble classification for detecting electricity fraud in traditional meters". In: *2021 24th International Conference on Computer and Information Technology (ICCIT)*. IEEE. 2021, pp. 1–6.

Recognitions and Awards

- Harry G. Miller Fellowships in Engineering (2025)
- The Wormley Family Graduate Fellowship (2025)
- Arthur Waynick Graduate Scholarship (2024)
- Milton and Albertha Langdon Memorial Fellowship (2023)
- Melvin P. Bloom Memorial Fellowship (2022)
- Undergrad Dean's List (2016–2018)
- Honorable Mention, Notre Dame College, Dhaka (2014)

Professional Service and Affiliations

- Reviewer, Design Automation Conference (DAC) 2025 [link]
- Reviewer, IEEE MWSCAS 2025 [link]
- Reviewer, IACCESS (2024)
- Member, Graduate Student Advisory Committee, Penn State (2024-Present)
- Student Member, IEEE (2015-Present)
- Executive Member, EDS, IEEE Bangladesh Section (2021-2022)
- Vice President, Notre Dame Nature Study Club (2013-2014)

Outreach and Leadership

Academic Service — Served as a lecturer at University of Liberal Arts Bangladesh (ULAB), teaching undergraduate courses and developing lab modules in electronics and device physics.

Research Leadership — Led and supervised student projects on semiconductor devices, circuits, and neuromorphic computing as a graduate research assistant and lecturer.

Interdisciplinary Collaboration	Collaborated with cross-functional teams in academia and industry on projects spanning AI, machine learning, and semiconductor process/device optimization.
Mentoring	Provided guidance and mentorship to undergraduate students, supporting their research initiatives and professional development.

References

Dr. Abhronil Sengupta	Associate Professor, Penn State University, Email: sengupta@psu.edu
Dr. Samia Subrina	Professor, BUET, Email: samiasubrina@eee.buet.ac.bd