

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

- 08/2022–05/2027 **Ph.D. in Electrical Engineering**, *Pennsylvania State University*, University Park, PA, USA, CGPA: 4.00/4.00
(Expected) 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
- Leading research on hardware-algorithm co-design for efficient intelligence at scale, optimizing Transformer-based LLMs for near-memory and in-memory computing (CIM/PIM) architectures.
 - Fabricated and characterized spintronic devices (e.g., hallbars, nanodots) using I-V and R-H loop measurements; utilized experimental data of emerging ferroelectric devices (e.g., FeFETs) to inform compact models and algorithm-hardware co-design.
 - Architecting RMAAT (Astrocyte-inspired transformers), an adaptive memory compression and replay system reducing long-context sequence modeling overhead.
 - Pioneered a hardware-aware training framework integrating hardware physics directly into system-level ML designs to co-optimize physical device constraints with ML accuracy.
 - Developed adaptive Spike-Timing-Dependent Plasticity (STDP) learning rules for dynamic Spiking Neural Networks (SNNs) to enable semi-supervised lifelong learning in cybersecurity threat detection.
- 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

- 05/2025–07/2025 **Graduate Technical Intern**, *Intel Corporation*, Hillsboro, OR
- Developed predictive analysis frameworks using Artificial Intelligence and statistical modeling (JMP) to optimize recipe parameters and accelerate semiconductor process flows.
 - Bridged domain gaps by integrating machine learning models with advanced material characterization to predict thin film deposition impact on technology node yields.
 - Designed and executed Design of Experiments (DOE) evaluating first-of-its-kind process integration tools to establish robust process windows.

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

- 07/2021 ○ 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

Core Expertise	Algorithm-hardware co-design (device-circuit-architecture-algorithm); Neuromorphic computing; AI hardware accelerators; DTCO & STCO; Transformer/LLM optimization; in-memory/near-memory computing (CIM/PIM)
ASIC/RTL & EDA	Logic synthesis, RTL design & verification (Verilog/SystemVerilog), ASIC design flow, FPGA prototyping; Cadence Virtuoso, Spectre, HSPICE, TCAD, Synopsys
Software & ML Sys.	Python, CUDA, C/C++, Shell/Bash; PyTorch, TensorFlow, JAX, ONNX, TensorRT; model compression (PTQ/QAT, pruning, distillation), hardware-aware ML, HPC, W&B, Matplotlib, Pandas
Device Physics	Spintronics, advanced NVM (FeFET, etc.), SRAM/DRAM design, compact modeling, Verilog-A, electrical characterization (DC/AC, IV/CV)
AI Dev.	Generative and agentic AI tools (Cursor, Copilot, etc.) for research, automation, and code development
Teaching & Comm	Scientific writing, peer review, research mentoring (15+ students), grant proposals, curriculum design, LaTeX

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. Pioneered a bioplausible transformer architecture leveraging neuron-astrocyte interactions to emulate self-attention mechanisms. Incorporated Hebbian and presynaptic plasticities with non-linearities and feedback dynamics, achieving superior accuracy and faster convergence on sentiment classification (IMDB), image classification (CIFAR-10), and language modeling (WikiText-2) tasks with improved perplexity compared to conventional transformers. Established the first scalable astromorphic framework for sequential tasks. See publication: [IEEE TCDS 2025].
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- RMAAT: Bio-Inspired Long-Context Transformers** Lead Student Researcher, 2024–Present. Developed RMAAT (Recurrent Memory Augmented Astromorphic Transformer), a recurrent transformer architecture for efficient long-context sequence processing. Integrated astrocyte-inspired memory compression via adaptive retention factors and linear-complexity attention from astrocyte short-term plasticity. Achieved competitive accuracy on Long Range Arena (LRA) benchmark with up to $1.73\times$ training speedup and $4.4\times$ memory reduction (3.4 GB vs. 15.0 GB) compared to standard recurrent transformers. Introduced AMRB (Astrocytic Memory Replay Backpropagation) training algorithm for memory-efficient recurrent learning. Accepted at ICLR 2026. See publication: [OpenReview].
- Neuromorphic Cybersecurity with Lifelong Learning** Lead Student Researcher, 2023–2025. Architected a Hierarchical Dynamic Spiking Neural Network (D-SNN) for Network Intrusion Detection Systems (NIDS) combining static SNN detection (94.3% accuracy) with adaptive dynamic SNN classification using GWR-inspired structural plasticity and novel Adaptive STDP (Ad-STDP) learning. Achieved 85.3% overall accuracy on UNSW-NB15 benchmark in semi-supervised lifelong learning scenarios, demonstrating superior adaptation to new attack types while mitigating catastrophic forgetting (5.3% improvement over static baseline). Demonstrated high operational sparsity (~ 0.0008 spike rate) suitable for neuromorphic hardware deployment. See publication: [arXiv], [ICONS 2025].
- Spintronic Device-Based Memory Systems** Lead Student Researcher, 2023–Present. Led end-to-end fabrication of spintronic memory arrays using e-beam lithography, sputtering deposition, and lift-off patterning. Performed comprehensive electrical characterization (I-V, R-H loops, retention, endurance) and extracted device parameters for compact model development. Advanced non-volatile memory technologies for neuromorphic computing and in-memory processing applications.
- 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. Achieved efficient processing with low latency and power consumption, suitable for wearable health monitoring applications.

Publications

- [1] **Md Zesun Ahmed Mia**, Malyaban Bal, and Abhronil Sengupta. “RMAAT: Astrocyte-Inspired Memory Compression and Replay for Efficient Long-Context Transformers”. In: *International Conference on Learning Representations (ICLR)*. 2026. URL: <https://openreview.net/forum?id=sTkJdbVxsI>.
- [2] **Md Zesun Ahmed Mia**, Malyaban Bal, Sen Lu, George M. Nishibuchi, Suhas Chelian, Srini Vasani, and Abhronil Sengupta. “Neuromorphic Cybersecurity with Semi-Supervised Lifelong Learning”. In: *Proceedings of the International Conference on Neuromorphic Systems (ICONS '25)*. IEEE Press, 2025, pp. 235–238. DOI: 10.1109/ICONS69015.2025.00043.
- [3] **Md Zesun Ahmed Mia**, Malyaban Bal, and Abhronil Sengupta. “Delving deeper into astromorphic transformers”. In: *IEEE Transactions on Cognitive and Developmental Systems* (2025).
- [4] Arnob Saha, **Md Zesun Ahmed Mia**, Jiahui Duan, Kai Ni, and Abhronil Sengupta. “Toward Variation-Tolerant Ferroelectric Neural Computing: Special Session Paper”. In: *2025 IEEE 68th International Midwest Symposium on Circuits and Systems (MWSCAS)*. IEEE. 2025, pp. 583–587.
- [5] **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.
- [6] **Md Zesun Ahmed Mia**, Nazmus Saadat As-Sauqib, Mehedi Hasan Himel, Mehedi Hossen Limon, and Samia Subrina. “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.
- [7] Tao Zhang, Mingjie Hu, **Md Zesun Ahmed Mia**, Hao Zhang, Wei Mao, Katsuyuki Fukutani, Hiroyuki Matsuzaki, Lingzhi Wen, Cong Wang, Hongbo Zhao, et al. “Self-sensitizable neuromorphic device based on adaptive hydrogen gradient”. In: *Matter* 7.5 (2024), pp. 1799–1816.
- [8] KM Ashrafu Hoque Fahim, Md Jubair Hasan Khalid, **Md Zesun Ahmed Mia**, and Mirza Rasheduzzaman. “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.
- [9] Md Moinul Islam, Monjurul Haque, Saiful Islam, **Md Zesun Ahmed Mia**, and SMA Mohaiminur Rahman. “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.

- [10] **Md Zesun Ahmed Mia**, Md Moinul Islam, Monjurul Haque, Saiful Islam, and SMA Mohaiminur Rahman. "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, IOP Physica Scripta (2026)
- Reviewer, IEEE Transactions on Neural Networks and Learning Systems (TNNLS) (2025)
- Reviewer, Design Automation Conference (DAC) (2025)
- Reviewer, IEEE International Midwest Symposium on Circuits and Systems (MWSCAS) (2025)
- Member, Graduate Student Advisory Committee, Penn State (2024–2026)
- Student Member, Institute of Electrical and Electronics Engineers (IEEE) (2015–Present)
- Executive Member, IEEE Electron Devices Society (EDS) Bangladesh Section (2021–2022)

Outreach and Leadership

- Mentorship** Mentored junior graduate students through neuroscience-inspired artificial intelligence research ideation and hands-on cleanroom fabrication workflows; supervised over 90 undergraduate students in senior capstone projects at Penn State, guiding end-to-end hardware/software integration and PCB design.
- Research Leadership** Core contributor within the Neuromorphic Computing Lab for multi-disciplinary federally funded research (NSF EFRI, Army Basic Scientific Research), driving milestones across cleanroom fabrication, circuit design, and AI development.
- Peer Review** Active technical reviewer for flagship journals and conferences including IEEE TNNLS, IOP Physica Scripta, Design Automation Conference (DAC), and IEEE MWSCAS.
- Academic Service** Serving on the Graduate Student Advisory Committee at Penn State (2024–2026). Previously served as a university Lecturer (ULAB, BUET), designing curricula and lab modules for foundational electronics and device physics.

References

- Dr. Abhronil Sengupta Associate Professor, Penn State University, Email: sengupta@psu.edu
- Dr. Swaroop Ghosh Professor, Penn State University, Email: szg212@psu.edu