SHUVRO CHOWDHURY, PhD

Postdoctoral Scholar | Probabilistic Computing, Quantum Computing & Machine Learning Researcher

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EDUCATION

Doctor of Philosophy in Electrical & Computer Engineering *2016 - 2022*

Purdue University, West Lafayette, IN | Advisor: Prof. Supriyo Datta

Dissertation: *Quantum Emulation with Probabilistic Computers*

Master of Science in Electrical & Electronic Engineering *2011 - 2014*

Bangladesh University of Engineering & Technology, Dhaka, Bangladesh

Dissertation: *Accurate drain current modeling of long channel junctionless double-gate field effect transistor*

Bachelor of Science in Electrical & Electronic Engineering *2006 - 2011*

Bangladesh University of Engineering & Technology, Dhaka, Bangladesh

RESEARCH SUMMARY

- An early-career researcher with over eight years of experience innovating at the intersection of probabilistic computing, quantum systems, and machine learning, recognized with the **2025 Misha Mahowald Prize** and over 20 publications in high-impact venues like Nature Electronics and Nature Communications.
- Expertise in the hardware-software co-design of probabilistic computers, pioneering the use of FPGAs and stochastic nanomagnets to accelerate complex tasks, including the emulation of sign-problem-free quantum Hamiltonians and solving hard combinatorial optimization problems.
- Develops scalable, physics-inspired AI solutions by applying energy-based models to diverse challenges, from training deep sparse Boltzmann networks to investigating algorithmic sparsity and designing energy-efficient edge implementations for Large Language Models (LLMs) and Neural Quantum States (NQS).
- Research is grounded in foundational device physics and quantum information theory, including prior work on analytical modeling for nanoscale semiconductor devices and the synthesis of reversible quantum circuits for multi-valued logic systems.

RESEARCH EXPERIENCE

Postdoctoral Scholar

2022 - Present

University of California Santa Barbara | Supervisor: Prof. Kerem Y. Camsari

- Led development of probabilistic computing hardware using FPGA and magnetic p-bits, resulting in 3 high-impact *Nature*-branded publications with additional works under review and in preparation
- Pioneered hardware acceleration techniques for Neural Quantum States (NQS) using probabilistic computing architectures
- Led development of Generalized Probabilistic Approximate Optimization Algorithm (PAOA)
- Investigated hardware acceleration techniques for chaotic bits (c-bits).
- Developed techniques to leverage sparsity in probabilistic algorithms, improving their efficiency for solving large-scale combinatorial optimization problems.
- Explored hardware-software co-design strategies for deploying Large Language Models (LLMs) on power-constrained edge devices.

Graduate Research Assistant

2016 - 2022

ECE, Purdue University | Supervisor: Prof. Supriyo Datta

- Developed novel quantum emulation methods using probabilistic computers, achieving up to 1000$\times$ acceleration over CPU-based simulations
- Designed and applied quantum-inspired probabilistic algorithms for classical optimization problems.
- Published breakthrough research on sign-problem-free Hamiltonian emulation in Physical Review Applied

HONORS AND AWARDS

[1] **The 2025 Misha Mahowald Prize** for the work on *Stochastic Neuromorphic Computing with Probabilistic Bits*.

[2] **3rd Prize** in Electronics group for undergraduate research work, EEE Undergraduate Project Workshop (EUProW) 2011, organized by Dept. of EEE, Bangladesh University of Engineering and Technology.

[3] **University Merit Scholarship** for good results in term examinations.

[4] **University Dean's List Award** for 3.75+ CGPA in all levels.

[5] **Dhaka Board Scholarship** for obtaining GPA 5.00 in Higher Secondary Certificate examination.

PEER-REVIEWED PUBLICATIONS

Journal Papers:

[1] **Shuvro Chowdhury**, Navid Anjum Aadit, Andrea Grimaldi, Eleonora Raimondo, Atharva Raut, P. Aaron Lott, Johan H. Mentink, Marek M. Rams, Federico Ricci-Tersenghi, Massimo Chiappini, Luke S. Theogarajan, Tathagata Srimani, Giovanni Finocchio, Masoud Mohseni, and Kerem Y. Camsari, "Pushing the boundary of quantum advantage in hard combinatorial optimization with probabilistic computers", in *Nature Communications*, 2025.

[2] **Shuvro Chowdhury**, Kerem Y. Camsari, and Supriyo Datta, "Accelerated quantum Monte Carlo with probabilistic computers" in *Communications Physics*, 2023.

[3] **Shuvro Chowdhury**, Kerem Y. Camsari, and Supriyo Datta, "Emulating Quantum Circuits With Generalized Ising Machines" in *IEEE Access*, 2023.

[4] **Shuvro Chowdhury**, Andrea Grimaldi, Navid Anjum Aadit, Shaila Niazi, Masoud Mohseni, Shun Kanai, Hideo Ohno, Shunsuke Fukami, Luke Theogarajan, Giovanni Finocchio, Supriyo Datta, and Kerem Y. Camsari, "A full-stack view of probabilistic computing with p-bits: devices, architectures and algorithms" in *IEEE Journal on Exploratory Solid-State Computational Devices and Circuits*, 2023.

[5] Srijan Nikhar, Sidharth Kannan, Navid Anjum Aadit, **Shuvro Chowdhury**, Kerem Y. Camsari, "All-to-all reconfigurability with sparse and higher-order Ising machines", in *Nature Communications*, 2024.

[6] Shaila Niazi, Navid Anjum Aadit, Masoud Mohseni, **Shuvro Chowdhury**, Yao Qin, and Kerem Y. Camsari, "Training Deep Boltzmann Networks with Sparse Ising Machines", in *Nature Electronics*, 2024.

[7] M. Mahmudul Hasan Sajeeb, Navid Anjum Aadit, **Shuvro Chowdhury**, Tong Wu, Cesely Smith, Dhruv Chinmay, Atharva Raut, Kerem Y. Camsari, Corentin Delacour, and Tathagata Srimani, "Scalable connectivity for Ising machines: Dense to sparse" in *Physical Review Applied*, 2025.

[8] Abdelrahman S Abdelrahman, **Shuvro Chowdhury**, Flaviano Morone, and Kerem Y Camsari, "Probabilistic approximate optimization: A new variational Monte Carlo algorithm", in *Nature Communications (accepted for publication)*, 2025.

[9] Saleh Bunaiyan, Corentin Delacour, **Shuvro Chowdhury**, Kyle Lee, and Kerem Y. Camsari, "IsingFormer: Augmenting Parallel Tempering With Learned Proposals", in *arXiv:2509.23043*, 2025.

[10] Kyle Lee, **Shuvro Chowdhury**, Kerem Y. Camsari "Noise-augmented Chaotic Ising Machines for Combinatorial Optimization and Sampling" in *Communications Physics*, 2024.

[11] Kerem Y. Camsari, **Shuvro Chowdhury**, and Supriyo Datta, "Scalable Emulation of Sign-Problem–Free Hamiltonians with Room-Temperature ***p***-bits", in *Physical Review Applied*, 2019.

[12] Mohammad Asif Zaman, **Shuvro Chowdhury**, "Modified Bézier Curves with Shape-Preserving Characteristics Using Differential Evolution Optimization Algorithm", in *Advances in Numerical Analysis*, 2013.

[13] Esmat Farzana, **Shuvro Chowdhury**, Rizvi Ahmed, and M. Khan, "Analysis of temperature and wave function penetration effects in nanoscale double-gate MOSFETs", *Applied Nanoscience*, 2012.

[14] Esmat Farzana, **Shuvro Chowdhury**, Rizvi Ahmed, and M. Z. Rahman Khan, "Performance Analysis of Nanoscale Double Gate MOSFETs with High-κ Gate Stack", *Applied Mechanics and Materials*, 2011.

Conference Papers:

[1] **Shuvro Chowdhury** and Kerem. Y. Camsari, "Machine Learning Quantum Systems with Magnetic p-bits," in *2023 IEEE International Magnetic Conference (INTERMAG)*, 2023.

[2] **Shuvro Chowdhury**, Supriyo Datta and Kerem Y. Camsari, "A Probabilistic Approach to Quantum Inspired Algorithms," in *2019 IEEE International Electron Devices Meeting (IEDM)*, 2019.

[3] **Shuvro Chowdhury**, Md. Ziaur Rahman Khan, "Surface potential modeling of Junctionless Double Gate MOSFETs using gradual depletion approximation," in *2014 International Conference on Electrical and Computer Engineering (ICECE)*, 2014.

[4] Nihal Sanjay Singh, Shaila Niazi, **Shuvro Chowdhury**, Kemal Selcuk, Haruna Kaneko, Keito Kobayashi, "Hardware Demonstration of Feedforward Stochastic Neural Networks with Fast MTJ-based p-bits", in *2023 International Electron Devices Meeting (IEDM)*, 2023.

[5] Andrea Grimaldi, Kemal Selcuk, Navid Anjum Aadit, Keito Kobayashi, Qixuan Cao, **Shuvro Chowdhury**, Giovanni Finocchio, Shun Kanai, Hideo Ohno, Shunsuke Fukami, Kerem Y. Camsari, "Experimental evaluation of simulated quantum annealing with MTJ-augmented p-bits" in *2022 International Electron Devices Meeting (IEDM)*, 2022.

[6] Md. Mahmud Muntakim Khan, Ayan Kumar Biswas, **Shuvro Chowdhury**, Masud Hasan, and Asif Islam Khan, "Synthesis of GF(3) Based Reversible/Quantum Logic Circuits without Garbage Output," in *IEEE International Symposium on Multiple-Valued Logic*, 2009.

[7] Ayan Kumar Biswas, **Shuvro Chowdhury**, Md. Mahmud Muntakim Khan, Masud Hasan, and Asif Islam Khan, "Some basic ternary operations using toffoli gates along with the cost of implementation," in *2011 41st IEEE International Symposium on Multiple-Valued Logic (ISMVL)*, 2011.

[8] Md. Mahmud Muntakim Khan, Ayan Kumar Biswas, **Shuvro Chowdhury**, Mehbuba Tanzid, Kazi Mohammad Mohsin, Masud Hasan, and Asif Islam Khan, "Quantum realization of some quaternary circuits," in *TENCON 2008 - 2008 IEEE Region 10 Conference*, 2008.

Peer-reviewed Workshop Papers:

[1] **Shuvro Chowdhury**, Shaila Niazi and Kerem Yunus Camsari, "Mean-Field Assisted Deep Boltzmann Learning with Probabilistic Computers", in Workshop Machine Learning with New Compute Paradigms, NeurIPS 2023.

Book Chapters:

[1] Kerem Y. Camsari, **Shuvro Chowdhury**, and Supriyo Datta, "The Non-Equilibrium Green Function (NEGF) Method", in *Springer Handbook of Semiconductor Devices*, 2021.

INVITED TALKS & SEMINARS

- **Shuvro Chowdhury** and Kerem Y. Camsari, *Pushing the Boundary of Quantum Advantage in Hard Combinatorial Optimization with Probabilistic Computers*, in Workshop on Rivals of Quantum Computing, University of Pittsburgh, May 2025.
- **Shuvro Chowdhury** and Kerem Y. Camsari, *A Full-Stack View of Probabilistic Computing with p-bits: Devices, Architectures, Algorithms*, IEEE SSCS Open Journal Webinar Series, February 2024.
- **Shuvro Chowdhury**, "Accelerated quantum Monte Carlo with probabilistic computers", in *International Network of Quantum Annealing (INQA) Seminar*, October 2023.
- **Shuvro Chowdhury**, "Probabilistic Computing with p-bits: Co-designing Devices, Algorithms and Architectures", in *Workshop on Non-conventional Approaches to Hard Optimization (NAHO)*, Sponsored by NSF and University of Notre Dame, USA, June 2023.

TECHNICAL SHORTCOURSES INSTRUCTED

- **Training on Computer Interfacing and Embedded System**, organized by – IEEE GOLD Bangladesh Section & ITRRC of Jagannath University, Dhaka, Bangladesh in 2013.
- **Workshop on LaTeX and Scientific Writing**, organized by – IEEE GOLD Bangladesh Section in 2013.
- **Short Course on FPGA Digital Logic Design**, organized by – IEEE ED/SSCS Bangladesh Chapter in 2013.
- Along with two other colleagues, jointly designed **'ATMEGA32 Development Kit'** - an ATMEGA32 microcontroller based trainer board.

TEACHING EXPERIENCE

Graduate Teaching Assistant *2020–2022*

ECE, Purdue University | Supervisor: Prof. Supriyo Datta

- Co-developed 1 graduate-level course (Boltzmann Law: Physics to Computing) and served as a teaching assistant in two courses: Fundamentals of Current Flow, Introduction to Quantum transport, each supporting over 40 students per semester for 3 years

Assistant Professor *2015–2016*

EEE, Bangladesh University of Engineering and Technology

- Theory Courses Taught: Solid State Devices, Electrical Properties of Materials, Microprocessor and Interfacing – 65 students per course
- Laboratory Courses Taught: Microprocessor and Interfacing Laboratory, Electronic Circuit Simulation Laboratory, Communication Laboratory, Measurement and Instrumentation Laboratory – 30 student per course

Lecturer *2011–2015*

EEE, Bangladesh University of Engineering and Technology

- Theory Courses Taught: Electrical Circuits I, Electrical and Electronic Technology, Microprocessor and Interfacing, Digital Logic Design – 65 students per course
- Laboratory Courses Taught: Microprocessor and Interfacing Laboratory, Control System Laboratory, Electrical Circuit Simulation Laboratory, Digital Logic Design Laboratory – 30 students per course

MENTORING EXPERIENCE

- Successfully mentored 5 graduate students in probabilistic computing, NQS, and FPGA development; this guidance directly contributed to two first-authored publications and a successful PhD placement at UC Santa Barbara for one of the mentees.

PROFESSIONAL AFFILIATIONS

- Member, Institute of Electrical and Electronics Engineers (IEEE)
- Member, IEEE Electron Devices and Solid-State Circuits Society (ED/SSCS)

TECHNICAL SKILLS

Programming Languages:

Python, C/C++, MATLAB, CUDA, Verilog, System Verilog

Machine Learning:

TensorFlow, PyTorch, Deep Learning, Energy-based models (Boltzmann Machines)

Quantum Computing:

Qiskit, Variational Algorithms, Quantum Monte Carlo, Quantum Annealing

Hardware & Simulation Tools:

FPGA (Vivado), SPICE, CAD Tools, NEGF Simulators

PROFESSIONAL SERVICE

Journal Referee

- Nature
- Nature Communications
- Nature Computational Science
- npj Unconventional Computing
- Electron Device Letters
- IEEE Transactions on Circuits and Systems
- NeurIPS Workshop on Machine Learning with new Compute Paradigms

Member *2011 - 2016*

Board of Undergraduate Studies, Dept. of EEE, Bangladesh University of Engineering and Technology

Member *2014 - 2016*

Bureau of Research, Testing and Consultation, Dept. of EEE, Bangladesh University of Engineering and Technology

Member *2014*

Technical Committee, 8th International Conference on Electrical and Computer Engineering (ICECE)

Vice Chair *2013*

GOLD Affinity Group, IEEE Bangladesh Section

Secretary *2013*

IEEE Electron Devices and Solid-State Circuits Society, Bangladesh Chapter

Secretary and Treasurer *2012*

IEEE Electron Devices and Solid-State Circuits Society (ED/SSCS), Bangladesh Chapter

Treasurer *2012*

GOLD Affinity Group, IEEE Bangladesh Section

Member *2012*

Technical Committee, 7th International Conference on Electrical and Computer Engineering (ICECE)

REFERENCES

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