Feroz Ahmed Mian

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Research Interests

Quantum LDPC code design (homological and commutative algebra, expander graphs) • single-shot decoding • circuit-level simulation and decoders • code–hardware co-design for neutral-atom arrays.

Education

Ph.D., Manning College of Information and Computer Sciences, UMass Amherst Sep 2025 – present
Advisor: Prof. Stefan Krastanov. Quantum error correction and fault-tolerant quantum computation.

B.S. Electrical Engineering, National University of Computer and Emerging Sciences, Lahore 2019 – 2023
Akhlaque Hussain Bronze Medal (3rd in graduating batch); Dean's List in six semesters.

Publications

1. A. Micciche, **F. A. Mian**, A. Chatterjee, A. McGregor, S. Krastanov. *Optimizing Compilation of Error Correction Codes for $2 \times n$ Quantum Dot Arrays and Its NP Hardness.* Phys. Rev. Research **8**, 013212 (2026).
2. **F. A. Mian**, O. Gwilliam, S. Krastanov. *Multivariate Multicycle Codes for Complete Single-Shot Decoding.* arXiv:2601.18879 (2026), under revision.
3. **F. A. Mian**, V. L. Addala, A. Meraj, A. Chadha, S. Krastanov. *Quantum Tanner Codes at Moderate Blocklength.* arXiv:2608.12509 (2026).
4. **F. A. Mian**, S. Zafar. *SoC-Based Implementation of 1D CNN for 3-Channel ECG Arrhythmia Classification via HLS4ML.* IEEE Embedded Systems Letters (2024).

Research Experience

Graduate Research Assistant, Krastanov Group, UMass Amherst Sep 2025 – present

- Developed **multivariate multicycle (MM) codes**, a Koszul-complex description of abelian multicycle codes. It covers bicycle, tricycle, 2BGA, generalized bicycle and toric codes, and gives closed-form check and metacheck matrices for both sectors.
- Determined when MM codes encode logical qubits and showed that the X and Z sectors are equivalent for even t. Found certified codes such as $[[144, 12, 12]]$, $[[486, 24, 12]]$ and $[[648, 60, 9]]$, plus examples with 5–9 generators and check weights 6–12.
- Led a search over non-abelian groups that found **quantum Tanner codes** at $n = 500$–1000 with distance bounds above 20, including $[[720, 6, (\leq 30, \leq 30)]]$ and $[[864, 8, (\leq 39, \leq 31)]]$. Seven of the eight highlighted codes beat $d = \sqrt{n}$.
- Built Stim/Sinter memory experiments under code-capacity, phenomenological and circuit-level noise, decoded with Tesseract, BP+OSD and overlapping-window decoders. Showed that metachecks improve single-stage BP+OSD, measured pseudo-thresholds (0.14–0.27% circuit-level) and few-shot plateaus, and tested hook-error-aware syndrome extraction on the Unity HPC cluster.
- Certified distances with QDistRnd, GPU-based sQetch (up to 3.5×10^8 trials), dist-m4ri and exact MILP (Gurobi).

Open-Source QEC Developer, QuantumSavory (mentor: Prof. Stefan Krastanov) Oct 2023 – Aug 2025

- Lead contributor of the error-correcting-code library in **QuantumClifford.jl** and **QECCore.jl**; developer of **QuantumExpanders.jl**. Wrote a solver-agnostic MILP minimum-distance solver and added non-abelian lifted product, 2BGA over finitely presented groups, D-dimensional surface/toric and new Tillich–Zémor codes.
- Placed 3rd globally in unitaryHack 2024 with contributions to Braket.jl, BraketSimulator.jl (AWS Braket) and Piccolo.jl (optimal control).

Research Assistant, NUCES Lahore (supervisor: Prof. Saima Zafar) Feb – Sep 2023
Designed an HLS4ML hardware–software co-design flow for a CNN accelerator on an FPGA SoC (IEEE ESL publication).

Skills

QEC tools: Stim, Sinter, Tesseract, ldpc (BP+OSD), QDistRnd, sQetch, dist-m4ri, JuMP/Gurobi. **Programming:** Julia (expert), Python, Oscar/Hecke/GAP, Git, LaTeX, Verilog/VHDL, high-level synthesis.

Talks, Posters and Honors

Poster, QEC 2026 (8th Int. Conf. on Quantum Error Correction, Santa Barbara) and talk, JuliaCon 2026: *Multivariate Multicycle Codes for Complete Single-Shot Decoding* • unitaryHack 2024, 3rd globally • IGNITE National Grassroots Research funding (2022–23).