



# Vahid Nourozi, Ph.D

✉ [Nourozi.v@gmail.com](mailto:Nourozi.v@gmail.com)  
✉ [Nourozi@nmsu.edu](mailto:Nourozi@nmsu.edu)  
✉ [Nourozi@aut.ac.ir](mailto:Nourozi@aut.ac.ir)  
✉ [v264025@dac.unicamp.br](mailto:v264025@dac.unicamp.br)

 +15753120494  
 +15753120494

## EDUCATION

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<b>New Mexico State University (NMSU)</b> , Las Cruces, NM, USA Ph.D. Student in Electronic Engineering <b>Work on:</b> quantum error correction and quantum computing Material: Quantum error correction, Coding theory, Information Theory, Signal Systems <b>Supervisor:</b> Prof. David G. M. Mitchell	<b>2023- Present</b>
<b>Amir Kabir University of Technology (Tehran Polytechnic)</b> , Tehran, Iran Ph.D. in Mathematics <b>Thesis:</b> THE RANK CARTIER OPERATOR AND LINEAR SYSTEM ON CURVES Material: Algebraic Geometry and Coding theory <b>Supervisor:</b> Prof. Farhad Rahmati and Prof. Saeed Tafazolian	<b>2016-2021</b>
<b>Universidade Estadual de Campinas (Unicamp)</b> , Campinas, Brazil Ph.D. Sandwich in Mathematics <b>Thesis:</b> THE RANK CARTIER OPERATOR AND LINEAR SYSTEM ON CURVES Material: Algebraic Geometry and Coding theory <b>Supervisor:</b> Prof. Saeed Tafazolian	<b>2019-2021</b>
<b>Tarbiat Modares University</b> , Tehran, Iran M.S. in Mathematics <b>Thesis:</b> PP-properties in Hurwitz series ring Material: Non-commutative Algebra <b>Supervisor:</b> Prof. Ahmad Moussavi	<b>2012-2014</b>
<b>Tafresh University</b> , Tafresh, Iran B.Sc. in Mathematics <b>Thesis:</b> ----- Material: Pure Mathematics <b>Supervisor:</b> Prof. Ali Parsiyan	<b>2008-2012</b>

## RESEARCH INTERESTS

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- Quantum error correction
- Quantum computing
- Algebraic Geometry
- Information Theory and machine learning
- Coding theory
- Algebraic Geometry Codes
- Quantum Algorithm

## PUBLICATION

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- ❏ (2024) V. Nourozi, D. G. M. Mitchell and A. Ashikhmin. Linear Scaling Quantum LDPC Codes via Balanced Products. Preprint.
- ❏ (2024) V. Nourozi. Quantum Error Correction with Goppa Codes from Maximal Curves: Design, Simulation, and Performance, to appear Discrete Mathematics, Algorithms and Applications
- ❏ (2024) V. Nourozi. Application of the Cartier Operator in Coding Theory. Finite Fields and Their Applications, 96, 102419.
- ❏ (2024) V. Nourozi and B. Mosallaei. The  $a$  –number of  $y^{q^2+q+1} = x^{q^2+1} + x^q$  over finite fields. Preprint.
- ❏ (2023) V. Nourozi and Farhad Rahmati, The Rank of the Cartier Operator on Picard Curves, Discrete Mathematics, Algorithms and Applications, 2450028.
- ❏ (2023) V. Nourozi, Goppa code and quantum stabilizer codes from plane curves given by separated polynomials, **Under review** in the Finite Fields and Their Applications.
- ❏ (2022) V. Nourozi and S. Tafazolian, The  $a$ -number of maximal curves of third largest genus, *AUT Journal of Mathematics and Computing* 3(1), 11-16
- (2022) V. Nourozi and F. Rahmati, The Rank of the Cartier operator on a certain  $F_q$  –Maximal function fields. *Missouri journal of mathematical sciences* , *Missouri Journal of Mathematical Sciences* 34 (2), 184-190
- ❏ (2022) V. Nourozi, F. Rahmati and S. Tafazolian, The  $a$ -number of Certain Hyperelliptic Curve. Iranian Journal of Science and Technology, Transactions A: Science, 1-5
- ❏ (2021) V. Nourozi, S. Tafazolian and F. Rahmati, The  $a$ -number of Certain Maximal Curve. *Transactions on Combinatorics*, 10(2), pp. 121-128.
- ❏ (2021) V. Nourozi and F. Rahmati, The  $a$ -number of plane curves given by separated polynomials, *Submitted*.
- ❏ (2021) V. Nourozi and F. Rahmati, Goppa code and quantum stabilizer codes from plane curves given by separated polynomials. *Submitted*.
- ❏ (2021) V. Nourozi and F. Rahmati, The  $a$ -number of special Maximal Curves. *Submitted*.
- ❏ (2020) V. Nourozi, F. Rahmati and M. Ahmadi, McCoy property of Hurwitz series rings. *Asian-European Journal of Mathematics* 14 (06), 2150105.
- ❏ (2019) V. Nourozi and F. Rahmati, Multivariate Ore Polynomials for Key Exchange Cryptographic Protocols. *The Third Conference on Computational Group Theory, Computational Number Theory and Applications, University of Kashan*.
- ❏ (2019) V. Nourozi and M. Afshar, Quantum Codes from Hyperelliptic Curves, *Southeast Asian Bulletin of Mathematics* 43 (3), 395–400.
- ❏ (2017) V. Nourozi, A. Moussavi and M. Ahmadi On Nilpotent Elements of Skew Hurwitz Polynomial Rings. *Southeast Asian Bulletin of Mathematics*, 41 (2), 239-248.
- ❏ (2015) M. Ahmadi, A. Moussavi and V. Nourozi, Nilradicals of skew Hurwitz series of rings, *Le Matematiche* 70 (1), 125-136.
- ❏ (2015) V. Nourozi, A. Moussavi and K. Sabzipour, Nil  $\alpha$ -Skew Armendariz property in skew Hurwitz polynomial rings, *Electronic Journal of Mathematics and its Applications*. 1 (1), 14-20.
- ❏ (2014) M. Ahmadi, A. Moussavi and V. Nourozi, On skew Hurwitz serieswise Armendariz rings, *Asian-European Journal of Mathematics* 7 (03), 1450036.
- ❏ (2014) V. Nourozi and A. Moussavi, Armendariz ring of Hurwitz series type. *The 23th seminar of algebra, Khansar*.

## Grants

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- ❏ 2024, ORNL National Lab, US Quantum Information Science, Oak Ridge National Lab, U.S.
- ❏ 2024, PHY-1818914, NSF, Quantum Ideas Summer School, Duke Quantum Center. Duke University, U.S.
- ❏ 2024, DMS-2303977, NSF, for attending and talking in the 14<sup>th</sup> Southeastern Quantum structure in the Lie theory workshop. University of Virginia, U.S.
- ❏ 2023, Fall NSF Innovation Corps and awarded a scholarship for my innovative concept. Project: Application of Quantum LDPC codes in 5G and IoT, New Mexico State University, U.S.
- ❏ 2019-2021, 314966/2018-8, TWAS-CNPq, Research on the Rank of Cartier operator. From Italy (TWAS) and Brazil (CNPq).

## Technical Skills

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- Programming Languages: Python, C/C++, MATLAB
- Quantum Computing Frameworks: Qiskit, Cirq
- High-Performance Computing: CUDA, OpenMP
- Quantum Error Correction: Surface codes, topological codes, stabilizer formalism

## Projects

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- **Quantum Error Correction Simulation**
  1. Implemented Shor's 9-qubit code and surface code for quantum error correction using Qiskit and custom C++ libraries
  2. Analyzed performance of minimum-weight perfect matching and belief propagation decoding algorithms
- **Large-Scale Quantum Circuit Simulation**
  1. Developed efficient simulation tools for quantum circuits with up to 50 qubits
  2. Utilized parallel computing techniques to optimize performance on CPU/GPU clusters
  3. Implemented in C++ and Python, achieving 100x speedup compared to naive implementation
- **Specialized Knowledge**
  1. Quantum Algorithm Design: Grover's algorithm, Quantum Fourier Transform, VQE, QAOA

## Quantum Algorithms and Applications Experience

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- Developed and simulated quantum error correction codes using Qiskit and custom C++ libraries
- Implemented Shor's 9-qubit code and surface code for quantum error correction
- Designed and analyzed performance of minimum-weight perfect matching and belief propagation decoding algorithms
- Benchmarked performance of quantum algorithms against classical counterparts
- Implemented Grover's algorithm and Quantum Fourier Transform for specific applications
- Experience with Variational Quantum Eigensolvers (VQE) and Quantum Approximate Optimization Algorithm (QAOA)
- Simulated large-scale quantum circuits (up to 50 qubits) using parallel computing techniques on CPU/GPU clusters
- Implemented quantum algorithms on IBM Quantum Experience platform
- Developed simulation framework for testing error correction techniques on noisy quantum hardware
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## Collaborative and Communication Experience

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- Presented research on Quantum Structure in Algebraic Geometry at the 14th Southeastern Quantum Structure in Lie Theory Workshop, University of Virginia
- Collaborated with international researchers during Ph.D. sandwich program at Universidade Estadual de Campinas, Brazil
- Participated in multi-disciplinary research projects combining mathematics, physics, and computer science
- Served as a reviewer for multiple academic journals, demonstrating ability to critically analyze and communicate complex ideas
- Actively participated in quantum computing workshops and challenges, including IBM Quantum Challenge and Quantum Ideas Summer School at Duke University

## Quantum Hardware Experience

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- Gained hands-on experience with IBM's superconducting qubit systems through IBM Quantum Experience
- Studied the principles of trapped-ion quantum computers during the Quantum Ideas Summer School at Duke University
- Conducted simulations of noise models for various quantum hardware architectures using Qiskit
- Explored the theoretical foundations of neutral-atom quantum computing systems
- Participated in a workshop on scaling challenges in quantum hardware at the US Quantum Information Science summer school
- Implemented error mitigation techniques for specific hardware noise profiles in quantum circuits

## Summer School

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- 📅 2024, Quantum Ideas Summer School, Duke Quantum Center, Duke University, U.S.

Topics covered: Quantum Computation Overview, Hardware Tutorials, Algorithms for Near-Term Devices, and Quantum Error Correction.

- 📅 2024, US Quantum Information Science, Oak Ridge National Lab, U.S.

Topics covered: Topological approaches to quantum computing, Cold atoms, and ion traps, Error mitigation and error correction, The current state of the quantum information science field, Applications of quantum technologies, quantum materials, and quantum sensing

- 📅 2024, IBM Quantum Challenge

Topics covered: Quantum States, Implementing an Optimization Algorithm using Variational Quantum Eigensolvers (VQE), Transpilation, Qiskit Ecosystem, Ai Transpiler, Circuit Knitting, Serverless, Variational Quantum Classifier (VQC), Running the Circuit on Quantum Hardware in Qiskit S.D.K 1.0.

- 📅 2024, IBM Qiskit Global Summer School

Topics covered: Quantum Circuit Transpilation, Qiskit Default and Custom Transpilation Methods, Error Per Layered Gate (EPLG), Layer Fidelity (LF), Quantum Error Suppression, Quantum Error Mitigation Techniques (Dynamical Decoupling, Measurement Error Mitigation, Gate Twirling, Zero Noise Extrapolation), Heisenberg Spin Chain Simulation, Qiskit Patterns Framework, Quantum Error Mitigation and Optimization Techniques.

- 📅 2024, Womanium Quantum Program + AI and QWorld

Topics covered: **Quantum Computing & Programming:** Basics of Quantum Systems, Operations on Real-Valued Qubits and Multiple Qubits, Entanglement and Protocols, Grover's Search Algorithm. **Quantum Algorithms & Programming:** Deutsch's Algorithm and Phase Kickback, Classical Gates, Deutsch Jozsa and Bernstein Vazirani, Simon's Algorithm, Intro to Cirq, Grover's Search, Max Cut and Adders. **Quantum Computing Hardware:** Quantum Annealing, Superconducting Quantum Computing, Silicon-based Quantum Computing, Photonic Quantum Computing, Neutral-atom Quantum Computing, Trapped-Ion Quantum Computing. **Quantum Annealing:** QUBO and penalty method, TSP, Graph Coloring and Ising Model, BQM and simulated annealing, Quantum annealing and hybrid solvers, Solving problems using D-Wave. **Artificial Intelligence:** AI for Climate, AI for Materials Discovery, AI for Atmospheric Science, AI for Computer Networking, AI & Quantum for Scientific Computing. **Quantum Algorithms Development - I:** Design a simple Quantum Algorithm, Quantum Bit Flip, Minimal Circuit Depth, Visualization, Execution, Implement a Multi-Control-X. **Quantum Algorithms Development - II:** Quantum Primitives 1, Quantum Primitives 2, Advanced Algorithms Design. **Quantum Machine Learning:** Intro to QML, Embeddings, and Ansatz, Hybrid models, QNNs, and quantum kernels, QML - Critical Thinking, Refining QNNs for improved Approximations, ZX-calculus and its application to QNNs

## Certificate

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- 2024, Quantum Computing & Programming with Qiskit using QWorld's introductory tutorial Bronze-Qiskit
- 2024, IBM, Quantum Challenge 2024 Achievement, Advanced
- 2024, IBM, Variational Algorithm Design, covered optimization techniques using Qiskit, Quantum algorithm ..
- 2024, IBM, Quantum Business Foundation, covered quantum to the business strategy, technology and operating model
- 2024, IBM, Basic of Quantum Information
- 2024, Ingenii, Quantum Machine Learning Fundamentals Course
- 2024, WOMANIUM, Quantum computing & Programing + AI program with Qiskit
- 2024, IBM, Qiskit Global 2024 Achievement, Advanced.
- 2024, Womanium Quantum Program + AI and QWorld, Quantum Algorithms
- 2024, Womanium Quantum Program + AI and QWorld, Quantum Annealing
- PennyLane Quantum Machine Learning Challenge at the Womanium Global Quantum +AI Program 2024

## Talk

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- 2024, Quantum Structure in Algebraic Geometry, In the 14<sup>th</sup> Southeastern Quantum structure in the Lie theory workshop. University of Virginia, U.S.

## Research Experiences

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- 2023- Present - Study and research on quantum computing – Quantum error correction, Quantum Algorithm, Quantum computing, Quantum encoding and decoding  
Supervisor: Prof. David Mitchell (New Mexico State University – U.S)
- 2016 – 2021 - Study and research on Algebraic Geometry – Cartier Operator, Coding theory, post-quantum cryptography, information theory  
Supervisor: Prof. Farhad Rahmti (Amir Kabir University – Iran) and Prof. Saeed Tafazolian (Unicamp- Brazil)
- 2018 - Member of Blockchain group at Amir Kabir University of Technology
- 2012-2014 - Study and research on Non-commutative Algebra – Group Theory and power series  
Supervisor: Prof. Ahmad Moussavi

## HONORS AND AWARDS

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- 2019 Awarded **Full Scholarship for graduate Program** from [The World Academy of Science](#) (TWAS), and [National Council for Scientific and Technological](#) (CNPq) to study Ph.D Sandwich at [Universidade Estadual de Campinas](#) (Unicamp).
- 2016 Awarded **Full Scholarship for graduate Program** from the ministry of science, research, and technology to study Ph.D at [Amir Kabir University of technology](#).
- 2016 Invited to the Ph.D interview without exam with master background.
- 2012 Awarded **Full Scholarship for graduate Program** from the ministry of science, research, and technology to study M.Sc. at [Tarbiat Modares University](#).
- 2014 Top student among 42 graduate students.
- 2008 Awarded **Full Scholarship for Undergraduate Program** from the ministry of science, research and technology to study B.Sc. at [Tafresh University](#).
- 2008 Ranked among **top 1 percent** in national university entrance exam among over 700,000 participants.

## Coursework's

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- Advanced Quantum Error Correction
- Quantum Algorithms and Complexity Theory
- Qiskit Quantum Information Theory
- Advanced Topics in Algebraic Geometry and Coding Theory

## Journal Reviewer

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- Referee of Transactions on Emerging Telecommunications Technologies
- Reviewer of American Mathematics Society
- Referee of IEEE Transactions on Industrial Informatics,
- Referee of Discrete Mathematics, Algorithms and Applications
- Referee of Peer-to-Peer Networking and Applications
- Referee of IEEE Internet of Things IoT
- AUT Journal of Mathematics and Computing

## LANGUAGE SKILLS

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**Persian** Native  
**English** Fluent  
**Portuguese** Intermediate

## SOCIETY AND COMMITTEE MEMBERSHIP

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American Mathematics Society	Association Member, Referee
Iranian Mathematical Society	Association Member

## Other

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2011 Member of the mathematics team of Tafresh University in the country's student mathematics competitions.

## Internet Link

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- [Google scholar](#)
- [Github](#)
- [Publons](#)
- [LinkedIn](#)
- [Researchgate](#)
- [Academia](#)
- [Personal Webpage](#)

## COMPUTER SKILLS

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<b>Technical Software</b>	Magma Software, Sage Software, Latex, Python, Qiskit, Matlab, C/C++. Cirq
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