Nazib E Elahi Khan Chowdhury

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Research & Technical Interests

Manufacturing analytics; industrial anomaly detection; time-series modeling; robotics perception; embedded sensing; ROS2 integration; energy efficiency in production lines; optimization and scheduling; applied machine learning for physical systems.

Education

University of Toronto, Toronto, ON *Sep 2024 – Jun 2026 (expected)*

Master of Engineering (MEng), Mechanical & Industrial Engineering | Data Analytics & ML Specialization

Relevant coursework: Deep Learning (MIE 1517), Big/Cloud Data Analytics (MIE 1628), Intelligent Sensor Networks (MIE 1050), Mobile Robotics & Perception (ROB 521), Machine Learning for Mathematical Optimization (MIE 1666), Scheduling (MIE 562).

Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh *Mar 2018 – May 2023*

B.Sc. in Mechanical Engineering | CGPA: 3.47/4.00

Selected coursework: Numerical Methods, Applied Engineering Mathematics, Differential Equations, Thermodynamics, Fluid Mechanics, Control Systems, Machine Design. Academic highlight: Achieved 4.00/4.00 GPA in all undergraduate mathematics courses.

Operations, Manufacturing & Mechanical Engineering Leadership

Team Leader / Project Manager, Team Interplanetar – BUET Mars Rover Team *Nov 2020 – Jun 2023*

Portfolio: buetinterplanetar.com

- Led a multidisciplinary team to **design, manufacture, integrate, and deliver** a competition-ready Mars Rover (European Rover Challenge & University Rover Challenge).
- **Front-line machinist coordination & manufacturing oversight:** Conducted frequent on-site visits to machine shops and manufacturing facilities to verify tolerances and surface finish; inspected parts for conformance; troubleshot nonconforming components directly with technicians and iterated design changes to improve manufacturability and assembly.
- **Supplier sourcing & procurement:** Visited local markets and workshops to source mechanical/electrical components; evaluated suppliers by quality, reliability, and lead time; maintained vendor relationships to secure best-value purchasing and reduced manufacturing delays.
- **Project management:** Owned schedules, budgets, procurement planning, and integration timelines; coordinated mechanical, electrical, software, science systems, and media sub-teams to meet aggressive milestones.
- **Budget ownership:** Managed annual budget of **$20,000**; maintained inventory and procurement records; achieved ~**95%** utilization through disciplined documentation and reporting.
- **System integration leadership:** Managed design changes across subsystem dependencies; structured testing, redesign, and contingency plans to ensure deliverability under tight deadlines.
- **Results:** Finals at **University Rover Challenge (USA)** ending a five-year drought; **8th place globally** at European Rover Challenge (out of 64 teams).

Mechanical Design & Manufacturing Sub-Team Leader, Team Interplanetar – BUET Mars Rover Team *Nov 2020 – Sep 2022*

- Planned mechanical design process and selected manufacturing methods for rover subsystems under strict time constraints.
- **6-DoF robotic arm (teleoperated):** Designed/manufactured a servicing-capable arm for object pickup, door opening, switch flipping, joystick/keyboard operation, screw turning, and field manipulation tasks.
- **Mobility system:** Designed hub-motor-driven wheels and suspension for rocky/sandy terrain; supported mechanical integration with drive subsystems and frame interfaces.
- **Structural analysis & validation:** Performed FEM simulations in ANSYS and SolidWorks Simulation under static loading; evaluated stress distributions across mesh refinements and validated designs against factor-of-safety

requirements for arm links, suspension members, wheels, chassis, and pin-hole interfaces.

- **Machinist coordination & validation:** Worked closely with machinists and factory-floor operators to clarify drawings, tolerances, hole specifications, and bending requirements; verified post-manufacturing dimensions and addressed deviations arising from machining, welding, or forming processes.
- **Mechatronics testing:** Used Arduino IDE to test arm actuation and wheel subsystems; validated mechanical clearances, backlash, mounting tolerances, and robustness during field trials.
- Competition achievements during the period: **8th place globally** at ERC 2022 (Top non-European team) and **Innovation Award** at IPAS Challenge 2021 for a Mars exploration drone concept using gas-compression heating to protect electronics.

Industry Data Analytics Experience

MEng Industry Project – Magna International (Toronto) *Jan 2025 – Present*

Factory Energy Analytics on Injection Molding Lines (Supervised by Prof. Chi-Guhn Lee, Dept. of MIE)

- Project impact (reported): identified patterns that could enable **$12,000/year** energy savings through early detection of inefficient behavior and abnormal cycles.
- Built a production-focused analytics workflow to characterize energy usage and identify inefficient machine behavior across multiple injection molding machines using historical time-series power data.
- **Data ingestion & cleaning:** Pulled power-sensor and machine-run data via an automated logging pipeline; handled missing segments, outliers, and misaligned timestamps; produced machine-run level datasets for downstream modeling.
- **Feature engineering:** Used rolling mean and rolling standard deviation to quantify variation in power consumption and separate machine states (idle vs production vs maintenance).
- **ML modeling:** Trained **Dynamic Time Warping (DTW) K-means** to cluster time-series patterns by shape; collaborated with factory experts to label clusters as operational phases.
- **Anomaly detection:** Computed DTW distance-to-centroid to detect abnormal runs; separated anomalies using percentile-based thresholds for both idle and production regimes.
- **Operationalization:** Designed threshold-based triggers and alert logic to notify operators/managers of abnormal machine behavior; created visual diagnostics (box plots, KDE, violin plots) and dashboards to communicate findings.
- **IT integration:** Coordinated with factory IT personnel to align data logging and alert integration with existing systems.

Accreditation Research Assistant, Temerty Faculty of Medicine, University of Toronto *Oct 2025 – Present*

Data Analytics (Work-Study)

- Collaborated with medical experts to analyze accreditation survey datasets across Ontario medical facilities.
- Translated complex survey results into clear summaries and visualizations; emphasized interpretability for decision makers.
- Performed data cleaning, aggregation, and exploratory analysis in Excel; communicated results using Power BI/PowerPoint.
- Independently studied standards/rules to understand operational context behind survey measures and improve accuracy of interpretation.

Robotics, AI & Data Projects

Autonomous Robotic Typing System (ROS2, Vision, Embedded Computing) – RSX, University of Toronto *2024 – Present*

- Implementing an autonomous typing pipeline where a robotic arm presses keys using vision-based key detection.
- Integrated Raspberry-Pi-class embedded computing, camera modules, and ROS2 perception pipelines for real-time detection and motion commands.
- Contributed to calibration and debugging in a multi-disciplinary robotics team setting.

Semantic Segmentation for Autonomous Perception (MIE 1517 Final Project) *2024*

- Developed a dual-stream semantic segmentation model combining semantic and boundary feature extraction to improve perception performance in robotics/autonomous driving scenarios.

Hierarchical Time-Series Forecasting (MIE 1628 Project) *2024*

- Implemented a neural network disaggregation approach for hierarchical sales forecasting (brand-level and item-level series), following a published methodology; built training/evaluation workflow for multi-level time-series prediction.

IoT Smart Home / Study-Space Sensing (MIE 1050 Project) *2024*

- Built an IoT device combining motion, ambient light, and environmental sensors to infer occupancy/activity patterns.
- Applied K-means clustering on sensor time-series for pattern recognition and occupancy classification; implemented logging/visualization for monitoring.

Reinforcement Learning (Course Projects / Self-Study) *2024 – 2025*

- Implemented RL agents for benchmark environments (e.g., Frozen Lake, Lunar Lander).
- Applied RL for optimization/decision-making problems (e.g., transport network design for bicycle infrastructure).

Natural Language Processing / LLM Training (Coursework & Kaggle) *2024 – Present*

- Trained sequence models and transformers (RNN, LSTM, GRU, BERT) for sentiment analysis and clustering.
- Ongoing: model training to detect rules violations on Reddit-post datasets (Kaggle competition).

Cloud Data Analytics & AI - Technical experience:

- **Azure Cloud Services + Database Management:** used it for building AI pipelines, automating data collection, transformation & storage to SQL Database;
- **Distributed Computing:** used Spark & Hadoop for parallel processing of tasks and speed up training machine learning algorithms — K-means, Canopy Clustering, Recommender Systems. Used Azure Table Distributions — Round Robin & Hash distributed SQL tables (course MIE 1628)
- **Workflow Automation** built AI pipelines with Spark, Hadoop, and Azure Cloud Services for large-scale data processing. Azure ML Web Service — batch analytics & stream analytics; Lambda & Kappa Architecture; IoT data streaming & real time analytics, (course MIE 1628)
- **Survey Tools:** used Google Forms & Microsoft forms for creating surveys for recruitment and product orders of club (BUET Mars Rover Team) when I was Team Leader. Analyzed survey reports using Google Forms built-in tools to generate pie charts, and bar plots showing skill distribution of new recruits.

Mechanical Engineering Core

Mechanical Design, CAD & Manufacturing

- **CAD design (5+ years):** Extensive experience designing complex mechanical parts and assemblies in SolidWorks, including robots, robotic arms, and large multi-part assemblies (100+ components). Produced full assemblies, exploded views, and animations for design reviews, manufacturing handoff, and external stakeholders.
- **Sheet metal & weldment design:** Designed sheet metal parts for laser cutting, shear cutting, and bending; generated 2D manufacturing drawings from 3D CAD showing bend lines, cut profiles, and tolerances. Created weldment diagrams for steel trusses and rover chassis; generated relative views and separated weldment bodies for individual fabrication and cutting.
- **Safety factor & Stress calculations:** have experience creating design of steel parts with known safety factor and did hand calculations to estimate loads on parts, and identify location of failure. Did FEM simulations on ANSYS to evaluate stress concentration on regions of interest, and did design changes as required.
- **DFM/DFA-focused design:** Applied Design for Manufacturing and Assembly (DFM/DFA) principles throughout the design lifecycle, including part simplification, fastener reduction, tolerance selection, GD&T , and manufacturing-process-aware geometry decisions.
- **Manufacturing processes:** Designed parts for lathe machining, milling, drilling, laser cutting, bending, welding, and additive manufacturing. Regularly worked with steel, aluminum, and wood components; selected tolerances appropriate for material behavior and process capability.
- **Welding distortion & fixturing awareness:** Designed weldments with consideration for thermal distortion and post-weld tolerance shifts; specified fixture requirements to minimize warping and dimensional deviation during welding.
- **Assembly planning & documentation:** Created Bills of Materials (BOMs), final assemblies, and step-by-step assembly diagrams; produced animations and printed guides to support manufacturing, integration, and stakeholder demonstrations.
- **Version Control:** have extensive experience controlling versions of CAD files and assemblies to try out different

configurations of the assembly in SolidWorks.

- **Kinematic layout & mechanism planning:** Used 2D block diagrams and kinematic planning in SolidWorks to define motion chains and degrees of freedom for robotic mechanisms, including a 6-DoF robotic arm.
- **Molded part design exposure:** Designed molded components and created mold cavities by subtracting part geometry, with awareness of manufacturability constraints.
- **Design leadership & review:** Led CAD design efforts for the rover; reviewed and approved designs from junior members, ensuring manufacturability, tolerance consistency, and system-level integration.

HVAC & Building Mechanical Systems experience

- **HVAC & building mechanical systems:** Academic and practical exposure to refrigeration and building mechanical systems through undergraduate coursework; familiar with HVAC system fundamentals including vapor-compression refrigeration cycles, air-conditioning components, and building thermal loads.
- **ASHRAE-based load calculations:** Experience calculating room-level cooling loads using ASHRAE standards, including sensible and latent heat contributions from occupants, lighting, equipment, envelope heat gains, and ventilation requirements.
- **Heat transfer equipment design:** Designed heat transfer equipment as part of coursework and hands-on projects, including thermal analysis and sizing based on heat transfer principles (conduction, convection, and overall heat transfer coefficients).
- **Shell-and-tube heat exchanger project (hands-on):** Designed and fabricated a shell-and-tube heat exchanger; performed thermal design and material selection based on heat transfer performance and manufacturability.
- **Manufacturing & fabrication of thermal systems:** Gained hands-on experience in manufacturing processes for thermal equipment, including plate cutting, tube-to-plate welding, gasket selection and sealing, lathe machining of components, and assembly; selected materials considering thermal conductivity, corrosion resistance, and mechanical strength.

Research

Thesis: "Analysis of Tensile Strength of High Entropy Alloy (FeCrCuCoNi) Using Molecular Dynamics + ML" *Final Year (BUET)*

- Combined LAMMPS molecular dynamics tensile simulations with Multi-Fidelity Physics-Informed Neural Networks (MPINN) for alloy tensile strength prediction.
- Implemented data processing and training workflows in Python using TensorFlow, NumPy, Pandas, and OS utilities for text/file manipulation.
- Created single-crystal and poly-crystal structures in Atomsk; visualized simulation results in OVITO.
- More info on www.nazibchowdhury.com

Teaching Experience

Teaching Assistant, University of Toronto *Sep 2024 – Apr 2026*

APS106 – Fundamentals of Computer Programming (Tutorial TA)

- Led tutorial for coding practices in Python; guided students step by step on algorithm creation and expressing that in Python code
- Taught basic programming techniques and data types, taught how to debug code and read error messages, and how to efficiently organize code.

MIE100 – Dynamics (Tutorial TA)

- Led tutorial problem-solving sessions on mechanics (dynamics); guided students through multi-step reasoning and application of theory.
- Authored and posted detailed notes/solutions on Quercus; supported Q&A/help sessions.

Adjunct Lecturer, Dept. of Computer Science & Engineering, Manarat International University *Aug 2023 – Dec 2023*

- Taught undergraduate courses in Machine Learning, Python Programming Lab (Intro to Programming), and Engineering Mathematics (Differential Equations, Coordinate Geometry, Numerical Methods).
- Developed course material and lesson plans; delivered theory and lab sessions; designed assignments/exams; evaluated student performance; collaborated with faculty to improve instructional materials.

Private Tutor *2018 – 2024*

- 6+ years tutoring A/O-level and university students in Calculus, Linear Algebra, Differential Equations, Physics, and Programming; created lecture notes and recorded lessons to support independent study.

Awards & Scholarships

- RISE Student Research Grant (BUET) for undergraduate thesis innovation and research excellence.
- European Rover Challenge 2022: 8th place globally (Top non-European team).
- IPAS Challenge 2021: Innovation Award for Mars exploration drone concept (gas-compression heating for electronics protection).
- Dean's List (Freshman & Sophomore years, BUET) and Merit Scholarships (multiple terms).
- Awarded by Directorate of Students Welfare (BUET) for Team Interplanetar achievements at ERC 2022 and IPAS 2021.

Selected Mechanical / Controls Projects (Additional)

- Autonomous line-following robot (Arduino + IR sensors); implemented PID control.
- PID controller for temperature control in a fluid-filled cavity by regulating wall velocity.
- Low-cost ventilator prototype adapting to patient breathing pressure fluctuations.
- Designed and tested a counter-flow heat exchanger exchanging heat between steam and process water.

Technical Skills

Manufacturing, Mechanical & Thermal: SolidWorks, AutoCAD, ANSYS (FEA), tolerance checking, DFM/DFA, mechanical integration, shop-floor coordination, HVAC fundamentals, heat transfer equipment design, root-cause troubleshooting of nonconformities.

Robotics & Embedded: ROS/ROS2, Gazebo (simulation exposure), Arduino IDE, Raspberry Pi, sensors (motion/light/environmental), camera modules, motor drivers, embedded C/C++.

Programming & Data: Python (NumPy, Pandas, SciPy, scikit-learn, Matplotlib), SQL, MATLAB, C/C++, Linux Bash, Git/GitHub.

AI/ML: PyTorch, TensorFlow, CNNs, RNN/LSTM/GRU, BERT, reinforcement learning, anomaly detection, K-means, Canopy clustering, DTW K-means, time-series forecasting.

Cloud & Big Data: Azure cloud services, Azure ML web services (batch/stream analytics), Spark, Hadoop, ETL/automation concepts (Lambda/Kappa architecture), IoT data streaming, SQL.

Visualization & Productivity: Power BI, Excel, PowerPoint, LaTeX, Canva, Microsoft/Google Forms, Google Classroom; basic media tooling (OpenShot) and basic photo editing.