Mustafa Rana

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Education

University of Toronto, St. George — Toronto, ON

Bachelor of Applied Science in Mechanical Engineering — *Sep. 2025 – Apr. 2030 (Expected)*

- **Relevant Coursework**: Engineering Design, Statics, Dynamics, Data Structures and Algorithms, Calculus I/II/III, Linear Algebra, Materials Science, Thermodynamics, Probability & Statistics, and Circuits

Technical Skills

Engineering & Design: SolidWorks, GD&T, MATLAB, Python, MS Office Suite, ANSYS Fluent

Programming & Analysis: Python (NumPy, pandas, scikit-learn, PyTorch, Matplotlib, SciPy), C, MATLAB, LaTeX

Research & Engineering Experience

Engineering Lead, Transmission System Design Project — Sep. 2026 – Present

University of Toronto — *Toronto, ON*

- Leading the conceptual design of a low-cost educational transmission platform incorporating a multi-stage gearbox and selectable gear ratios to demonstrate relationships between input speed, torque, and mechanical advantage.
- Currently working on preliminary **CAD, engineering drawings, and a bill of materials** for potential candidate designs for the gearbox

Aerodynamics Member, Rocketry Division — Sep. 2026 – Present

University of Toronto Aerospace Team — *Toronto, ON*

- Currently working on Flow Reattachment Devices and investigating whether aerodynamic features intended to control separation or encourage flow reattachment could improve rocket aerodynamic performance in useful flight regimes.

Research Intern, Laboratory of Advanced Membranes and Separations — Jun. 2026 – Jul. 2026

Lahore University of Management Sciences — *Hybrid*

- Replicated a published multi-effect desalination (MED) prediction workflow in Python, using **6,000 experimental records** and **7 thermal and flow inputs** to predict distillate production.
- Built a reproducible ANN pipeline with a 70/30 train-test split and training-only input scaling, achieving $R^2 = 0.8794$ and **RMSE = 0.07921** on **1,800 held-out records**.

Undergraduate Research Assistant — Feb. 2026 – Present

University of Sheffield — *Remote*

- Developing and validating an **ANSYS Fluent** model of a rotating packed bed for carbon-capture applications using experimental pressure-drop data, investigating geometry, meshing, boundary conditions, packing resistance, and convergence.
- Analyzed pressure-loss mechanisms to distinguish packing resistance from non-packing friction and documented modelling assumptions, experimental comparisons, limitations, and results for regular research discussions.

Project Lead, NovaGlove Heated Astronomy Glove System — Feb. 2026 – Apr. 2026

University of Toronto – Praxis II — *Toronto, ON*

- Led development of **NovaGlove**, a dual-layer heated glove for astronomers designed to preserve fine-motor dexterity during **4–6 hour** observing sessions in temperatures as low as $-20°\mathbf{C}$.
- Engineered a **7.4 V** heating system using flexible polyimide heating elements, PWM temperature control, a silk inner glove, and removable neoprene insulation, reaching approximately $41°\mathbf{C}$ with a projected **10-hour battery life**.
- Developed physical, mathematical, and thermal prototypes; evaluated manipulation across **7 telescope-control geometries** and simulated heat distribution at $-10°\mathbf{C}$ to validate dexterity and thermal performance against stakeholder requirements from the Royal Astronomical Society of Canada.

Intern, Virtual Software Infrastructure — Jul. 2023 – Aug. 2023

Systems Ltd. — *Lahore, Pakistan*

- Collaborated with multidisciplinary UX/UI designers to identify usability problems, organize user research, and iteratively develop prototype solutions.
- Conducted structured interviews and large-scale surveys, analyzed findings, and translated user feedback into wireframes and evidence-based design recommendations.

Assistant Teacher, Physics Aug. 2024 – May 2025

TNS Beaconhouse *Lahore, Pakistan*

- Worked directly with students to identify areas of difficulty, explain technical concepts clearly, and guide them through problems individually.
- Reviewed calculations, methodology, and technical reports, providing structured feedback and helping students resolve errors in their work.
- Helped design IB Internal Assessment Lab Reports, generated actionable feedback, worked in tandem with the Sciences Lead to ensure all topics were focused, accurate, and possible to carry out for every student

Engineering Projects

Save the North – Satellite Emissions Verification Agent | *Python, FastAPI, React, TypeScript* Sep. 2026

- Built a hackathon prototype that processes NASA EMIT satellite methane imagery to identify and quantify industrial emissions, estimating a measured plume at approximately **23 t/h $\mathbf{CH_4}$** using integrated-mass-enhancement calculations and Monte Carlo uncertainty analysis.
- Integrated satellite imagery, wind data, facility records, and environmental regulations into an AI-assisted pipeline producing traceable emissions assessments, source analysis, visualizations, and regulatory screening reports.

Matboard Bridge Design & Structural Optimization | *MATLAB, Analysis, Fabrication* Nov. – Dec. 2025

- Designed and fabricated a **1260 mm** matboard bridge under strict material and geometric constraints, optimizing the cross-section for bending strength, shear resistance, buckling stability, and manufacturability.
- Developed MATLAB tools to calculate section properties and predict structural failure modes, achieving approximately **90% agreement** between predicted and experimental failure performance.

NACA 0012 Airfoil Pressure Distribution Analysis | *Experimental Aerodynamics, Analysis* Jun. – Aug. 2024

- Analyzed experimental pressure measurements from a NACA 0012 airfoil tested at approximately **20 m/s**, evaluating pressure distributions across **20 surface tapping points** over multiple angles of attack.
- Integrated surface-pressure data to determine lift coefficients and investigate $C_{L,\max}$ **and stall angle**, comparing experimental aerodynamic behaviour with theoretical expectations.