PATRICK J. SINGAL

p.singal@columbia.edu | New York, NY | psingal.ca

EXPERIENCES

Chemical Kinetics & Combustion Researcher *Burke Lab, Columbia University* *Sep. 2022 – Present*

- Updating, validating, and optimizing chemical kinetics models by developing novel simulation techniques and applying physics-based, theory-informed numerical approaches.
- Journal publications (Google Scholar): "Implementation of New Mixture Rules Has a Substantial Impact on Combustion Predictions for H_2 and NH_3", Proc. Combust. Inst. 40 (2024); "Current Gaps in Pressure-Dependent Chemistry Impact Engine-Relevant Ammonia Combustion Behavior", Combust. Flame 283 (2026).
- Software (GitHub): Cantera 3.1+ (co-developer), LMRRfactory (pre-release).
- Oral presentations: 2024 International Combustion Symposium (Milan, Italy), 2024 Spring Meeting of the ESSCI (Athens, GA), 2025 US National Combustion Meeting (Boston, MA), 2026 Spring Meeting of the ESSCI (Raleigh, NC).
- Lead Teaching Assistant (TA): Intro to Combustion (Fall 2025), Advanced Thermodynamics (Spring 2026).

Undergraduate Researcher *Queen's University* *Sep. 2021 – Apr. 2022*

- Explosion Physics & Prevention Lab: Simulated turbulent, compressible flow through an engine fuel supply valve using ANSYS Fluent as part of an undergraduate thesis: "CFD simulation of turbulent, compressible flow through rotating detonation engine supply valve" (2022). Assisted with rotating detonation engine experiments in which propagating detonation waves were captured using high-speed Schlieren imaging and built-in pressure transducers, which provided experimental grounding for CFD models.
- Rival Lab: Designed a NACA0012 airfoil in SolidWorks, which contains 16 internal pressure-measurement channels, taps, and transducer ports that are geometrically optimized to reduce noise and signal error. The model was subsequently 3D-printed by partners at EPFL in Switzerland, where it was used to perform water-tunnel testing.

Capstone Project *MEDATech Engineering* *Sep. 2021 – Apr. 2022*

- Designed an optimized thermal management system for a heavy-duty electric mining vehicle, which regulates the sensitive operating temperatures of Li-ion batteries, motors, and auxiliary components throughout various drive cycles and loading conditions. Created a Simulink model of the TMS that simulates required heat removal rate in response to transient fluctuations in battery heat generation. Used Simulink to model the proposed TMS as a feedback control system that uses solenoid valves to modulate coolant flow rate in response to measured temperature changes in the battery packs.
- Project was featured in an official university news release (May 2023).

Founder, Manager *Queen's Vertical Farming Team (QVFT.ca)* *Sep. 2019 – Apr. 2022*

- Founded Canada's first undergraduate vertical farming R&D team, which aims to design and build a functional software-automated aeroponic farm on Queen's campus. Led, trained and coordinated the diverse projects of 40 past and present members. Established a network of partners in industry and academia.
- Created a comprehensive model of the farm prototype using SolidWorks. Strategically placed check valves, pressure release valves, and other fittings to prevent backflow, cavitation, and excess pressure buildup. Used fluid mechanics principles and MATLAB to determine the pump size and pipe dimensions that sufficiently pressurize the sprinkler nozzles; added intermediate reservoirs with gravity-fed inlets and submerged outlets to reduce the pump suction line's length and maintain watertightness. Flowcharted and wrote Arduino code for a feedback control system that automatically maintains optimal growth conditions with sensors, actuators, and microcontrollers.

Code Life Ventilator Challenge *McGill University, MGH Foundation* *Mar. 2020*

- Collaborated with professional engineers to design a low-cost, oxygen-generating mechanical ventilator for COVID-19 patients in developing countries; ranked in top 65/1,029 at this international competition.

EDUCATION

PhD., Mechanical Engineering

Columbia University
New York, NY
2022 – 2027
M.S. received 2023

BASc., Mechanical Engineering

Queen's University
Kingston, ON
2018 – 2022

SKILLS

- Transient simulation, model validation, numerical methods for PDEs
- SolidWorks, Cantera, Simulink, ANSYS Fluent
- Python, C++

AWARDS

- Charles P. Fenimore Best Student Presentation, ESSCI (2024)
- Top 65/1,029 at Code Life Ventilator Challenge (2020)
- 1st place at Accenture QGIC case competition (2019)

- Fluid dynamics, chemical kinetics, thermodynamics, combustion
- Linux OS, command-line scripting