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THERMOFLUIDS

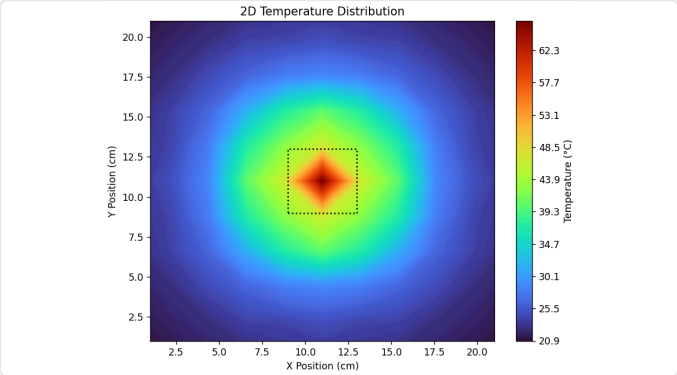
Heat and Mass Transfer: Electronics Cooling

University of Toronto, MIE313 (Heat and Mass Transfer) · Winter 2025 · Group project

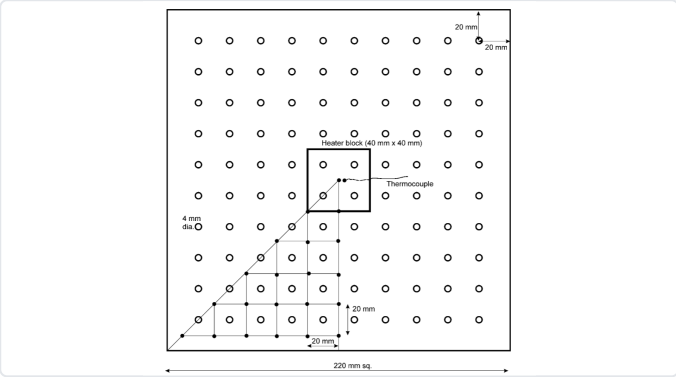
Experiment and modeling

Convection labs and a finned heat-sink design, framed around keeping electronics and batteries cool.

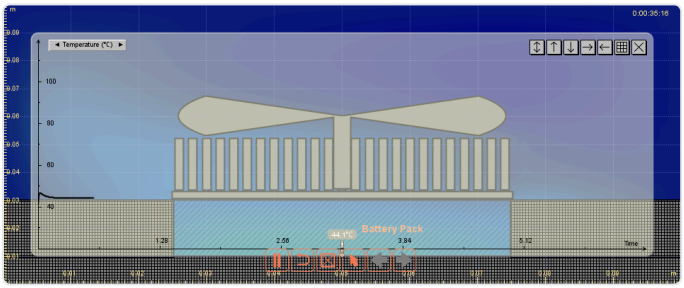
A set of thermal-systems labs built around electronics cooling. They measure natural and forced convection on a heated block, model two-dimensional heat spreading across a circuit board with a finite-difference grid, and design a finned aluminum heat sink to hold an electric-vehicle battery pack below 60 C. I contributed experiment, theory, and the written analysis.



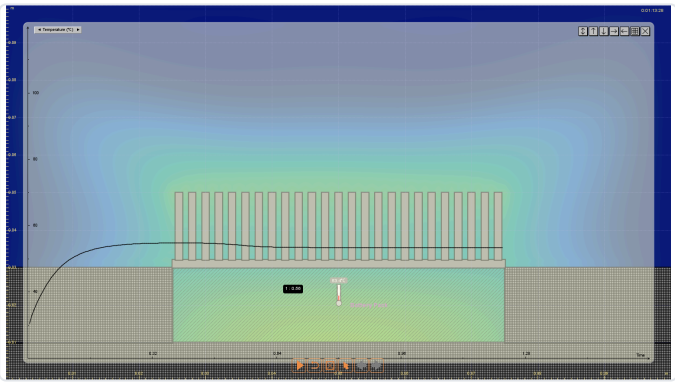
My 2D temperature-distribution heatmap of the circuit board, peaking near the heater.



The finite-difference nodal grid used to model the board.



Energy2D simulation of the finned heat sink cooling the battery pack.



A candidate finned heat-sink geometry.

Convection and board thermal model

Transient temperature data on a heated aluminum block gives the natural and forced convection coefficients through a lumped-capacitance fit in Python. A two-dimensional finite-difference nodal model then estimates the board's effective conductivity and maps its temperature field, which peaks near the heater.

EV battery heat sink

Using Newton's law of cooling in an Energy2D simulation, the team sized a finned aluminum heat sink for a battery pack generating up to 1.26 by 10^6 W per cubic metre, comparing a natural-convection design against a fan-assisted one on cost and energy. Without a heat sink the pack centre reached 120 C.

SELECTED REFERENCES

- "A comprehensive review on thermal management of electronic devices," J. of Engineering and Applied Science (Springer) 70, 2023.
- "Thermal management of Li-ion battery packs in EVs using an innovative heat sink design," ScienceDirect, 2025.
- Y. Cengel, A. Ghajar, Heat and Mass Transfer: Fundamentals and Applications.

Engineering portfolio brief. Course and team project; contribution as noted above.