

MASTER'S THESIS 2026

# Title

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Title

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*Title*

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## Abstract

bla bla

**Keywords:** *Physics Informed Neural Network, ..., ...*

# Acknowledgements

# List of Acronyms

**EV** electric vehicle. 1

**FE** finite element. 1

**Li** lithium. 1

**Li B** lithium-ion battery. 1

**PINN** physics-informed neural network. 1

**RMSE** root-mean-squared error. 3

# Contents

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# 1

## Introduction

### 1.1 Background

With an ever growing demand for convenient energy storage, the use of lithium-ion batteries (Li Bs) in portable devices have skyrocketed over the last 30 years.

physics-informed neural network (PINN), electric vehicle (EV), lithium (Li)

#### Contents

- Why batteries? (Nobel prize 2019, a game changer in our modern lives, necessary for climate change)
- However, there are still problems, and the hunt for even more energy efficient batteries requires models to describe the physical properties of batteries.
- While models based on finite element (FE) can be used to simulate such systems to a high accuracy, they are often computationally costly [1]. Instead, .

### 1.2 Aim and Scope





# 2

## Theory

### 2.1 Overview of Batteries

- A battery's parts, anode, cathode, electrolyte. Cell vs. module.
- The general working principle: charging and discharging. Potential negative effects that need to be considered. Heat development, or other factors affecting performance of the cell.
- What equations are governing? (Thermodynamics, Mechanics, electric, chemical)

### 2.2 Neural Networks

- General overview of neural networks. Explain neurons, weights, bias, loss function, different types of NNs. RNN??
- How to make NNs PINNs?
- 

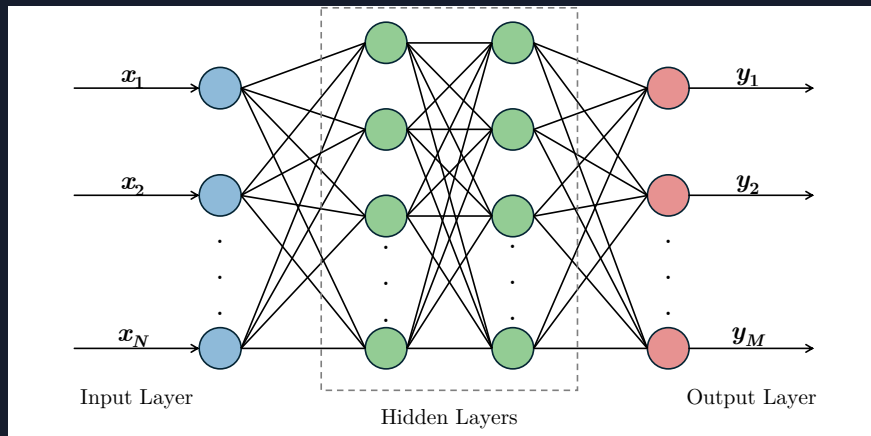


FIG 2.1: Schematic view of a neural network where each circle represents a single neuron. An input signal  $\mathbf{X} = \{\mathbf{x}_i\}_{i=0}^N$  enters the model in the input layer, proceeds through the hidden layers, and exits from the output layer. This process produces an output  $\mathbf{Y} = \{\mathbf{y}_i\}_{i=0}^M$ , which can be interpreted as a prediction based on the input data.

Loss function, such as root-mean-squared error (RMSE).

# 3

## Method

Here's the method

# 4

## Results and Discussion

Here are the results

# 5

## Conclusion

Here's the conclusion

# Bibliography

- [1] A. Asheri, M. Fathidoost, V. Glavas, S. Rezaei, and B.-X. Xu, “Data-driven multiscale simulation of solid-state batteries via machine learning,” *Computational Materials Science*, vol. 226, p. 112 186, 2023, ISSN: 0927-0256. DOI: <https://doi.org/10.1016/j.commatsci.2023.112186>. [Online]. Available: <https://www.sciencedirect.com/science/article/pii/S0927025623001805>.
- [2] J. Haraldsson, “Msc thesis,” *Chalmers*, vol. 1, no. 1, 2026.

# A

## Appendix A: Extra Stuff

In FIG. A.1, ...



FIG A.1: hej