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REVERSE ENGINEERING SUPERCAPACITORS

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Outline

- **Introduction**
 - **Project Aims and Motivation**
 - **Background**
- **Project Plan**
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- **Conclusion**



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Introduction

Project Aims and Motivation
Objectives
Background

Project Aims and Motivation

Motivation

Lithium are used in most house battery. It has high internal resistance, low power density, less cost effective, hazardous and cannot be recycled.

Aim

To investigate the characteristic of various types of supercapacitor and see if a cluster of the best capacitor can be used as an alternative to a Tesla house battery.

Background

Comparison Table[1,2]

Properties	Lithium Battery	Supercapacitor
Electronic Storage	Involve chemical phase/composition change	Direct
Energy Density	High	Low
Internal Resistance	High	Low
Operating Temperature Window	Narrow	Wide
Lifespan	Short	Long
Power Density	Low	High
Disposability	Low	High
Recyclability	No	High
Cost	High	Low

Objectives

- Theory & Methodology
- Project and Experimental Planning
- Supercapacitor's selection & purchase (around 3000F)
- Test and Analysis (I-V Characteristic, output impedance, return efficiency and internal structure & material)
- Final Design Analysis



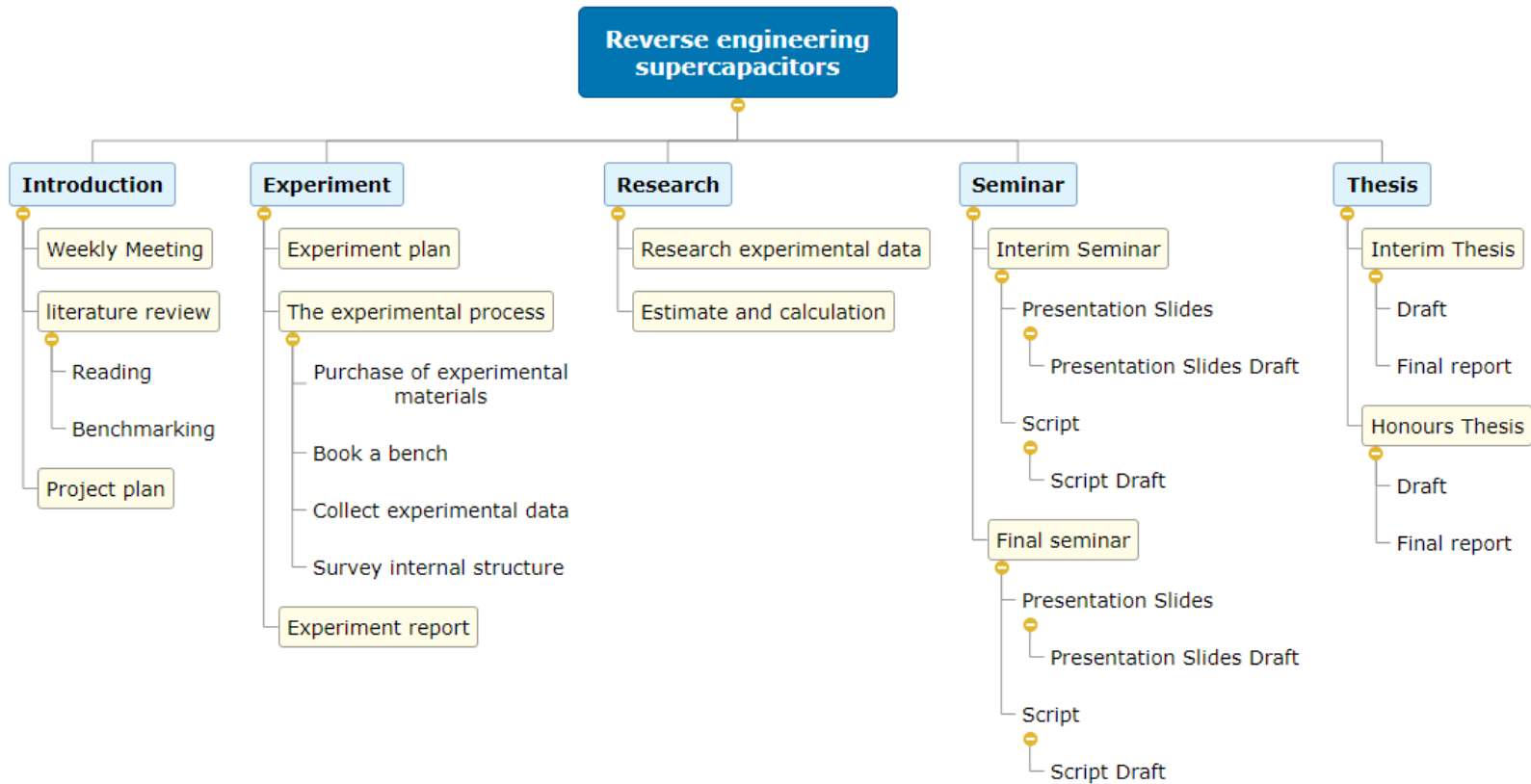
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Project Plan

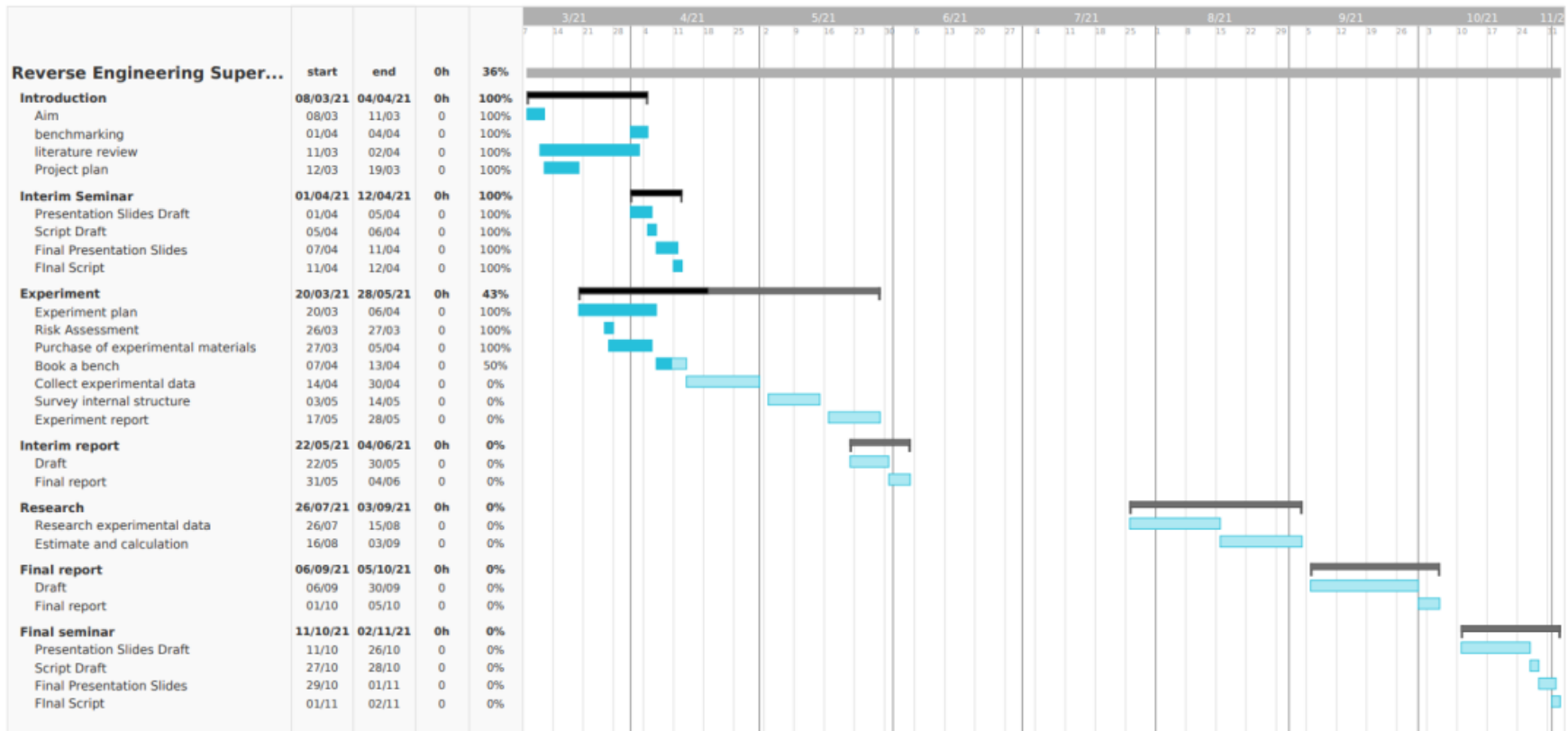
Project Planning

- **Project Progress Plan**
 - **Work Breakdown Structure**
 - **Gantt Chart**
- **Previous Studies**
 - **Benchmarking**
- **Project Failure Analysis**
- **Budget**
- **Experimental Planning**
 - **Electrical test**
 - **Physical test**
- **Data Processing and Results Analysis**
- **Final Design Modelling**

Work Breakdown Structure



Gantt Chart



Previous Study

Equivalent circuit models[1]

- Electrical behaviour of supercapacitor
- Parameterised RC network
- Model with ODEs
- \uparrow sophistication, \uparrow accuracy

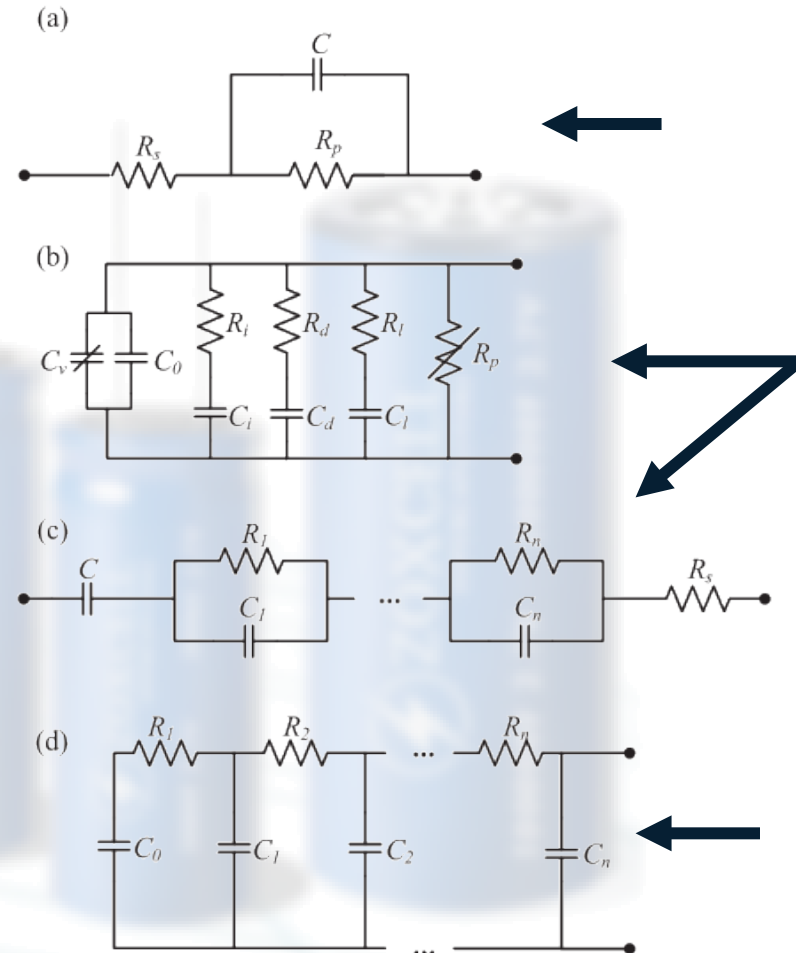


Fig. 2. Equivalent circuit models[1].

Project Failure Analysis

COVID-19

Might experience unpredictable lock down and community infection which obstruct the lab experiment process.

- Risk Level: High
- Mitigation: Ensure social distancing and other COVID safety measure is always being abide.
- Risk Level after Mitigation: Medium

Budget

Budget insufficiency.

- Risk Level: Medium
- Mitigation: Plan the process and expenses thoroughly before making any decision or purchases.
- Risk Level after Mitigation: Low

Data Loss




Hard copy or electronic data lost or became unavailable

- Risk Level: Medium
- Mitigation: Save multiple copies of data and information.
- Risk Level: Low

Budget

Direct Income and Expenditure

Income Source	Amount (AUD)
The University of Adelaide	250
Total =	250

Expenditure items		Source	Amount (AUD)
2.7V 3000F Super Farad Capacitor Long Foot Low ESR High Frequency Ultracapacitor		Ebay	75.74
Super Capacitor 2.8V 3000F Low ESR High Frequency For Car Auto Power Supply			56.70
Stock Screw type SuperCapacitor 2.7V 3000F Capacitor 2.7V3000F Fala		Alibaba	26.80
Total =			135.00

In-kind Support

Supported items	Supported by	Estimate cost
Workshop facilities tears and wears	The University of Adelaide	100.00
Workshop space		300.00
Spare parts		30.00
Total =		430.00

Expense Budget

Expenses	Cost (AUD)
Expenditure(cash)	135.00
In-kind Support	430.00
Total Budget =	565.00

Experimental Planning

- Safety Risk Assessment MUST be completed before any test.
- Buy 3000F supercapacitors of several different materials.

Electrical Test

- Electronics Projects Lab EM307
- Observe and study the properties of supercapacitors:
 - Decide an isolation method
 - Decide a power supply method
 - Measure the voltage with known reference resistance
 - Measure voltage of the capacitor.
 - Then the capacitance can be acquired

Physical Test

- Adelaide Microscopy Center
- Break the supercapacitors
- Observe microscopic structure of the material

Results and Analysis

- I-V Characteristic
- Output impedance
- Return efficiency
- Internal structure & material

Final Design Modelling

- Estimate how many supercapacitors are needed to make a house battery with same or better performance.
- Estimate the final design volume and weight.



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Conclusion

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- ~~• Background~~
- ~~• Work Breakdown Structure~~
- ~~• Previous Studies~~
- ~~• Project Failure Analysis~~
- ~~• Budget~~
- ~~• Experimental Planning and Methodology~~
- Data Processing and Methodology
- Final Design Modelling

Reference

- [1]L. Zhang, X. Hu, Z. Wang, F. Sun and D. Dorrell, "A review of supercapacitor modeling, estimation, and applications: A control/management perspective", *Renewable and Sustainable Energy Reviews*, vol. 81, pp. 1868-1878, 2018. Available: [10.1016/j.rser.2017.05.283](https://doi.org/10.1016/j.rser.2017.05.283).
- [2]N. Devillers, S. Jemei, M. Péra, D. Bienaimé and F. Gustin, "Review of characterization methods for supercapacitor modelling", *Journal of Power Sources*, vol. 246, pp. 596-608, 2014. Available: [10.1016/j.jpowsour.2013.07.116](https://doi.org/10.1016/j.jpowsour.2013.07.116).
- [3]F. Rafik, H. Gualous, R. Gallay, A. Crausaz and A. Berthon, "Frequency, thermal and voltage supercapacitor characterization and modeling", *Journal of Power Sources*, vol. 165, no. 2, pp. 928-934, 2007. Available: [10.1016/j.jpowsour.2006.12.021](https://doi.org/10.1016/j.jpowsour.2006.12.021).



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