THE UNIVERSITY OF SYDNEY

SCHOOL OF AEROSPACE, MECHANICAL, MECHATRONIC, AND ELECTRICAL ENGINEERING

Aeroelastic Flutter Suppression

Honours Thesis Proposal

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1 Introduction

1.1 Background

When it comes to designing supersonic airfoils, one of the main aerodynamic and structural factors that need to be considered is the aeroelastic flutter speed of the wing. Flutter as defined by Principles of Aeroelasticiy [1] is the dynamic instability of an elastic body in the air stream. When a body undergoes flutter, it can lead to a dramatic correction of the system which in a general leads to the failure of the structure. For the most part this has been avoided through passive means in which the structure is designed around the flight envelope of the aircraft or the flight envelope is limited to the structural properties. Some active methods do exist however, these are usually chosen second to the passive methods.

1.2 Aim

This thesis will look to implement an active control method to three main simulations. A two dimensional, 3 degree of freedom simulation using the analytical equations of motion. A two dimensional solution using a numerical solver. Finally a 3 dimensional solution using a numerical solver. The controllers will be designed around an initial calculation based on the first simulation and adjusted to fit the following ones.

2 Literature Review

2.1 Aerodynamics

Title: Principles of Aeroelasticity
Authors: Raymond L. Blisplinghoff, Holt. Ashley
Summary: This is the base for which a lot of the aeroelastic theory will be drawn from. This book provides an entire chapter on flutter and gives the base for which the early model simulations are based off. It also goes through aeroelastic theory in great detail and will provide a good insight into the theory.

2.2 Solution Options

Title: Active Control Method On Flutter Suppression Of a High-Aspect-Ratio Two-Dimensional Airfoil with a Control Surface
Authors: P. Yang, Q. D. Li, Z. Ren, Q. K. Tan and Y. Fan
Summary: This is a more detailed version of the Two dimensional model. This conference paper helped as the reference for which the initial system was made. It provided results and parameters that could be used to verify the model along with references that will be used in further development. This model uses a LQR controller which although won't be used in this thesis, can be a point of further development of the research.

3 Proposed Outline

The following subsections will be named according to the proposed chapter outline of the thesis. Within each subsection will be a small summary of the proposed content.

3.1 Acknowledgements

This section will seek to acknowledge all those who helped to produce this report including the use of facilities, software, and current or previous research.

3.2 Chapter 1: Introduction

In this section, the topics surrounding this research will be introduced to the readers. In particular, the types of flutter that occur in rocket/ high aspect-ratio foils at transonic and supersonic speeds. Along with this the chapter will briefly summarise the topics in the report and the previous work done in the area.

3.3 Chapter 2: Literature Review

This chapter will provide a a short review on the various pieces of literature and research that has been used to design, conduct and verify/ validate the experiments and results seen in this report.

3.4 Chapter 3: Governing Equations & Simulation Models

During this section, the theories behind both the analytical models and the numerical models used throughout the research will be summarised. A more detailed derivation and explanation behind these theories will be provided in the appendix.

3.5 Chapter 4: Controller Designs

This chapter, as given in the proposed title, this section will outline the controller designs and the evolution of the controllers as the simulation becomes more advanced. This section will also provide methods for gain tuning and the evolution of that as the simulations improve.

3.6 Chapter 5: Results & Discussion

This section will provide and discuss the results of the tests, their possible meanings and the validity of them. It will also discuss the errors and inaccuracies in the system and the possible improvements

3.7 Chapter 6: Conclusion

As the final section to the main report, this will seek to conclude the work that has been done and summarise the conclusions that have been reached from the experiment.

3.8 References, Appendix

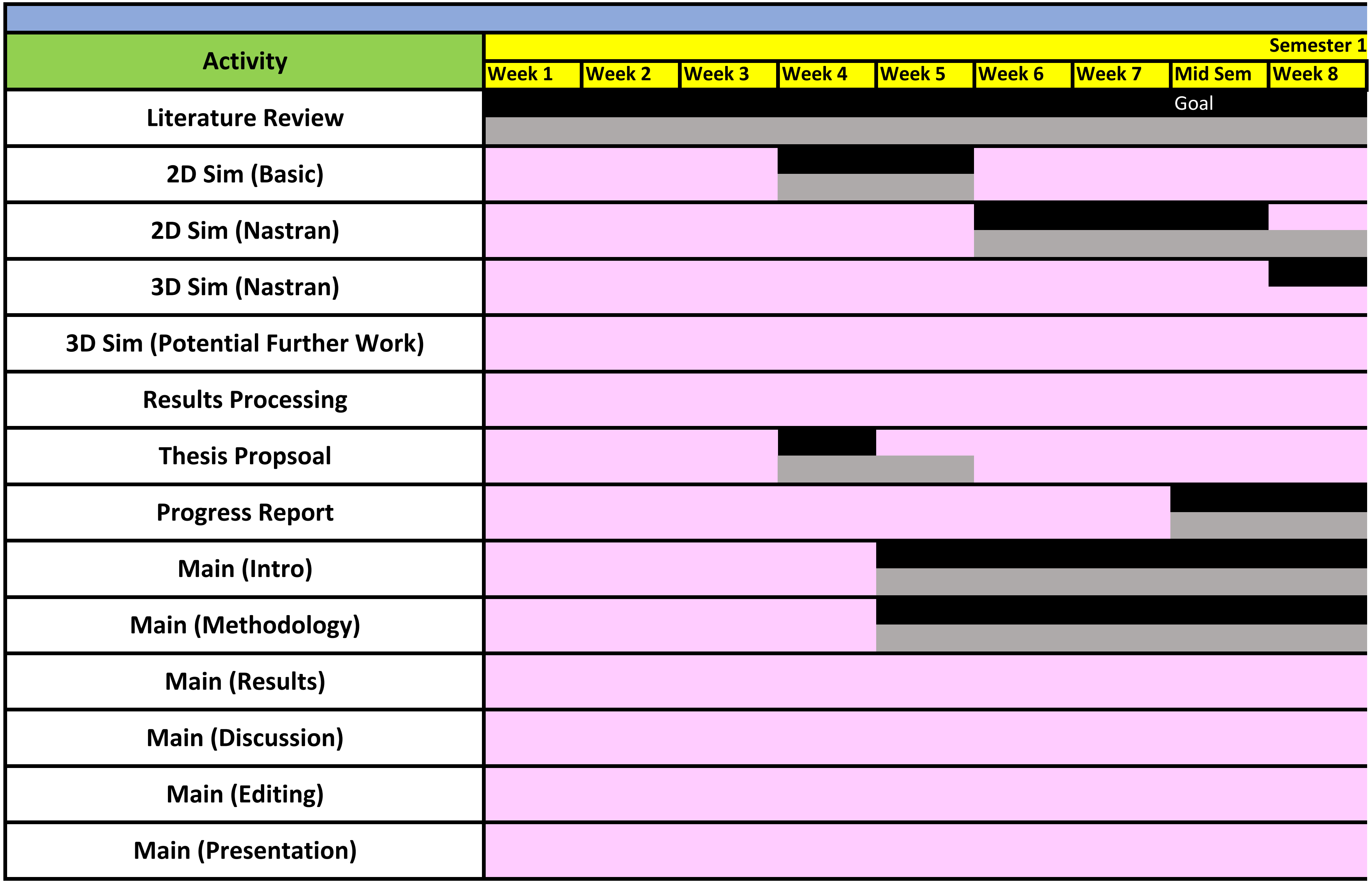
Following the conclusion will be a section of references presented in IEEE format. A set of appendices will be presented to help support the topics and results presented in the report.

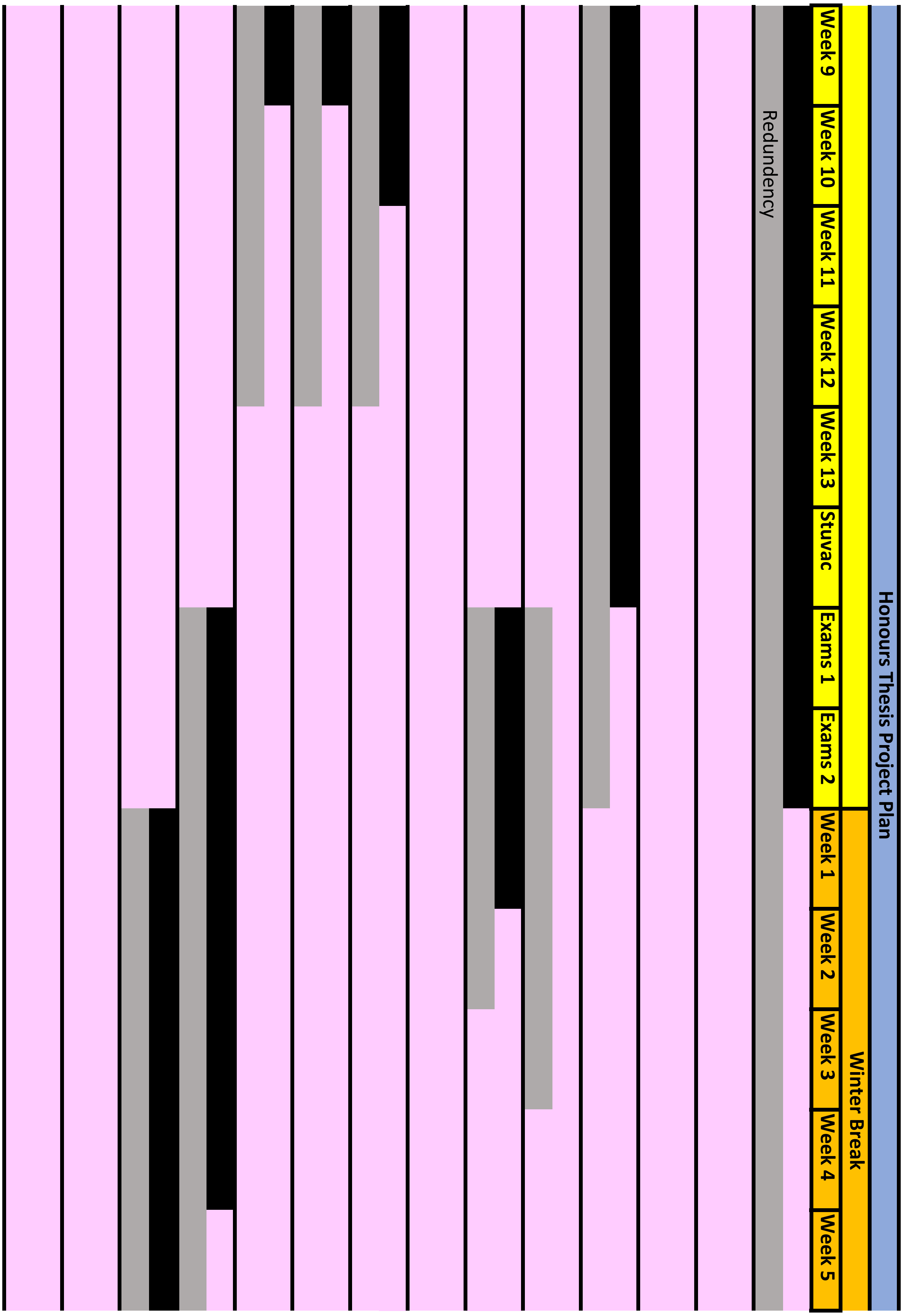
4 Current Work

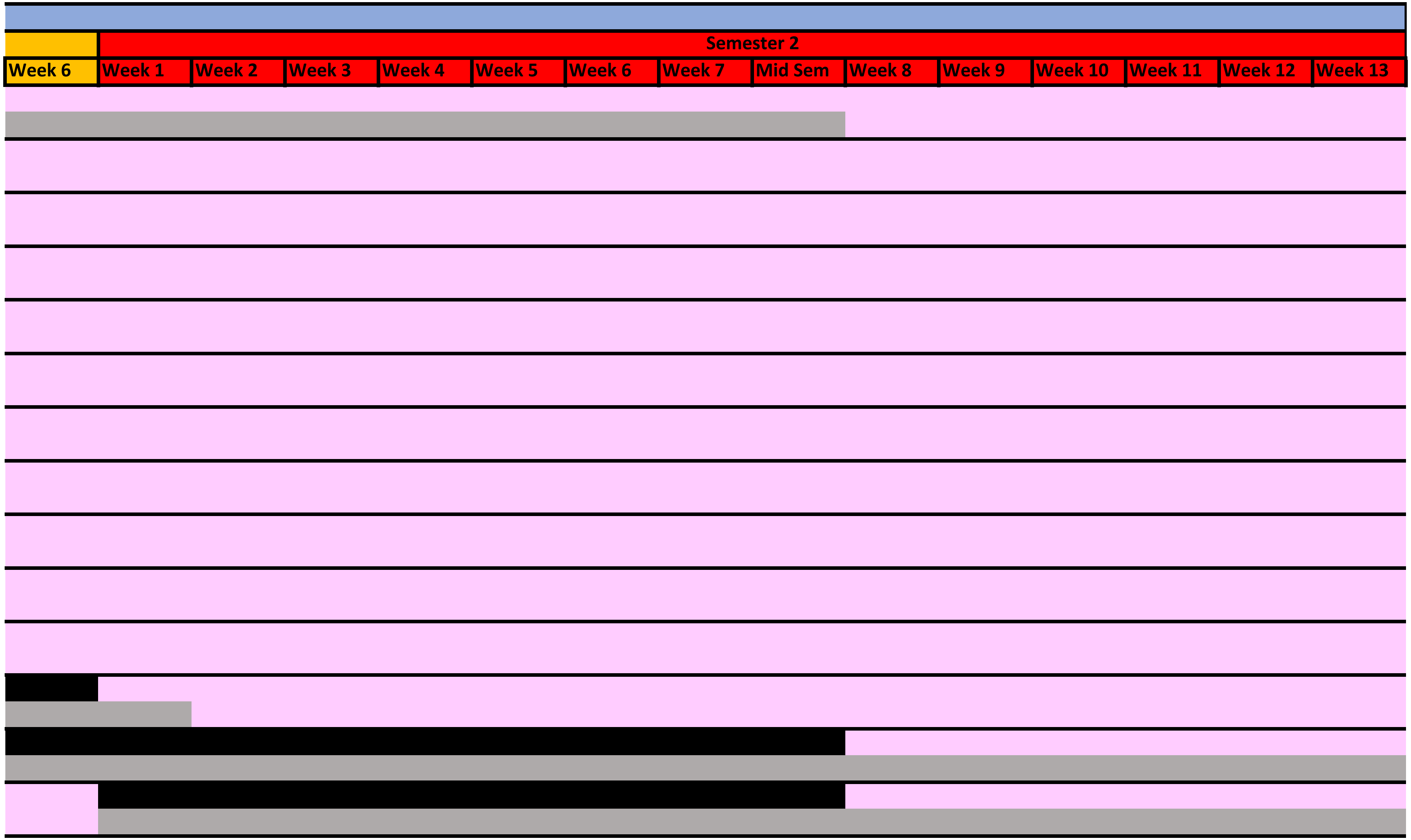
Currently, the 2D model is looking to be completed by the end of this week. The mathematics have been taken from the literature and the program is being done up. The plan according to the Gantt chart is still on track and results should be available by the end of the week.

5 Plan of Completion

See the following Gantt Chart.


Activity
Semester 1
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Mid Sem
Week 8
Goal
Literature Review
2D Sim (Basic)
2D Sim (Nastran)
3D Sim (Nastran)
3D Sim (Potential Further Work)
Results Processing
Thesis Propsoal
Progress Report
Main (Intro)
Main (Methodology)
Main (Results)
Main (Discussion)
Main (Editing)
Main (Presentation)


Honours Thesis Project Plan
Winter Break
Week 9
Week 10
Week 11
Week 12
Week 13
Stuvac
Exams 1
Exams 2
Week 1
Week 2
Week 3
Week 4
Week 5
Redundancy


Semester 2
Week 6
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Mid Sem
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13

6 References

1. R.L. Bisplinghoff, "Flutter", "Principles of Aeroelasticity", 1st Edition, New York, United States of America, John Wiley and Sons INC., Chpt 9,pp. 527-631