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# Title

Mechatronic Project 478  
Final Report

Author: Rayde Krüger  
24723061

Supervisor: Dr. DNJ Els

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Department of Mechanical and Mechatronic Engineering  
Stellenbosch University  
Private Bag X1, Matieland 7602, South Africa.

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# Executive summary

<b>Title of Project</b>
...
<b>Objectives</b>
...
<b>What is current practice and what are its limitations?</b>
...
<b>What is new in this project?</b>
...
<b>If the project is successful, how will it make a difference?</b>
...
<b>What are the risks to the project being a success? Why is it expected to be successful?</b>
...
<b>What contributions have/will other students made/make?</b>
...
<b>Which aspects of the project will carry on after completion and why?</b>
...
<b>What arrangements have been/will be made to expedite continuation?</b>
...

# Acknowledgements

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# List of symbols

## Constants

$$L_0 = 300 \text{ mm}$$

## Variables

$Re_D$	Reynolds number (diameter) . . . . .	[ ]
$x$	Coordinate . . . . .	[ m ]
$\ddot{x}$	Acceleration . . . . .	[ m/s <sup>2</sup> ]
$\theta$	Rotation angle . . . . .	[ rad ]
$\tau$	Moment . . . . .	[ N·m ]

## Vectors and Tensors

$\vec{v}$	Physical vector, see equation ...
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## Subscripts

$a$	Adiabatic
$a$	Coordinate

## Abbreviations

DEM	Discrete Element Method
FEA	Finite Element Analysis



# Chapter 1

## Introduction

### 1.1 Background

Starting from the big picture, gradually narrow focus down to this project and where this report fits in. Hello world.

### 1.2 Objectives

The objectives of the project (in some cases the objectives of the report). If necessary describe limitations to the scope.

### 1.3 Motivation

Why this specific project/report is worthwhile.

# Chapter 2

## Literature review

### 2.1 Discrete element method

The Discrete Element Method (DEM) analysis (Cundall and Strack, 1979) uses spherical objects. Lin and Ng (1997) developed a DEM model for ellipsoids.

# Chapter 3

## Content chapter

Unless the chapter heading already makes it clear, an introductory paragraph that explains how this chapter contributes to the objectives of the report/project.

### 3.1 Heading level 2

#### 3.1.1 Heading level 3

##### 3.1.1.1 Deepest heading, only if you cannot do without it

**Equations:** An equation must read like part of the text. The solution of the quadratic equation  $ax^2 + bx + c = 0$  given by the following expression (note the full stop after the equation to indicate the end of the sentence):

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2b}. \quad (3.1)$$

In other cases the equation is in the middle of the sentence. Then the paragraph following the equation should start with a small letter. Euler's identity is

$$e^{i\pi} + 1 = 0, \quad (3.2)$$

where  $e$  is Euler's number, the base of natural logarithms.

The `amsmath` has a wealth of structure and information on formatting of mathematical equations.

**Symbols and numbers:** Symbols that represent values of properties should be printed in italics, but SI units and names of functions (e.g.  $\sin$ ,  $\cos$  and  $\tan$ ) must not be printed in italics. There must be a small hard space between a number and its unit, e.g. 120 km. Use the `siunitx` package to typeset numbers, angles and quantities with units:

$$\begin{aligned}\backslash\mathrm{num}\{1.23\mathrm{e}3\} &\rightarrow 1.23\times 10^3 \\ \backslash\mathrm{ang}\{30\} &\rightarrow 30^\circ \\ \backslash\mathrm{qty}\{20\}\{\mathrm{N.m}\} &\rightarrow 20\,\mathrm{N.m}\end{aligned}$$

**Figures and tables:** The `graphicx` package can import PDF, PNG and JPG graphic files.

Table 3.1: Standard ISO paper sizes

Paper	Sizes	
	$W$	$H$
	[mm]	[mm]
A0	841	1189
A1	594	841
A2	420	594
A3	297	420
A4	210	297
A5	148	210

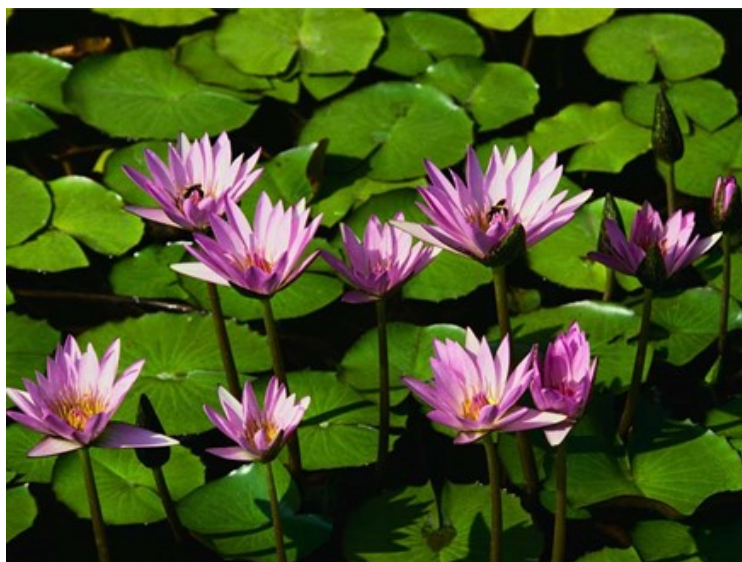


Figure 3.1: Water plants

## Chapter 4

## Conclusions

# Appendix A

## Mathematical proofs

### A.1 Euler's equation

Euler's equation gives the relationship between the trigonometric functions and the complex exponential function.

$$e^{i\theta} = \cos \theta + i \sin \theta \quad (\text{A.1})$$

Inserting  $\theta = \pi$  in (A.1) results in Euler's identity

$$e^{i\pi} + 1 = 0 \quad (\text{A.2})$$

### A.2 Navier Stokes equation

The Navier–Stokes equations mathematically express momentum balance and conservation of mass for Newtonian fluids. Navier-Stokes equations using tensor notation:

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x_j} [\rho u_j] = 0 \quad (\text{A.3a})$$

$$\frac{\partial}{\partial t} (\rho u_i) + \frac{\partial}{\partial x_j} [\rho u_i u_j + p \delta_{ij} - \tau_{ji}] = 0, \quad i = 1, 2, 3 \quad (\text{A.3b})$$

$$\frac{\partial}{\partial t} (\rho e_0) + \frac{\partial}{\partial x_j} [\rho u_j e_0 + u_j p + q_j - u_i \tau_{ij}] = 0 \quad (\text{A.3c})$$

## Appendix B

### Experimental results

# List of references

- Cundall, P.A. and Strack, O.D.L. (1979). A discrete numerical model for granular assemblies. *Géotechnique*, vol. 29, no. 1, pp. 47–65.
- Lin, X. and Ng, T.T. (1997). A three-dimensional discrete element model using arrays of ellipsoids. *Géotechnique*, vol. 47, no. 2, pp. 319–329.