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WHICH MAY SPAN MULTIPLE LINES  
(BUT NO MORE THAN 3 LINES)

by

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A dissertation submitted in partial fulfillment  
of the requirements for the degree

of

Doctor of Philosophy

in

Physics

MONTANA STATE UNIVERSITY  
Bozeman, Montana

October 2019

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## DEDICATION

I dedicate this to all MSU students who use L<sup>A</sup>T<sub>E</sub>X. Dedication is optional and may be no longer than one page, single spaced, and should precede the acknowledgments page.

## ACKNOWLEDGEMENTS

I would like acknowledge the countless engineers, technicians, and scientists who made the FIREBIRD, AC-6, and RBSP missions a success. This work was supported by Montana State University and by NASA Headquarters under the NASA Earth and Space Science Fellowship Program - Grant 80NSSC18K1204. *Add co-author support.*

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## NOMENCLATURE

$\mu$	Dynamic viscosity
$\mathbf{n}$	Normal vector
$\mathbf{u}$	Velocity vector

## ABSTRACT

The abstract must be single spaced and no more than 350 words. The abstract must contain the following elements: (1) statement of the problem, (2) procedure or methods, (3) results, and (4) conclusions. Mathematical formulas, abbreviations, diagrams, and other illustrative materials should not be included. It should be written to be understood by a person who does not have expertise in the field.

## INTRODUCTION

Welcome to the Montana State University electronic Thesis/Dissertation (ETD) L<sup>A</sup>T<sub>E</sub>X template. In this chapter various sections, subsections, and subsubsections are created and filled with random text). In Ch. 2 methods to write equations and how to include figures and tables are explored. Conclusions are drawn in Ch. 3.

### Section

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Subsection With a Very Very Very Very  
Very Very Very Very Very Very Long Title

For long subsection titles use the command `\longsubsection{#1}{#2}`, where `#1` is the first line of the long title, and `#2` is the second line of the long title. You can also pass an optional argument to this command that puts a shorter title in the table of contents as shown by the subsection below.

Subsection With a Very Long Title  
But Shortened in the Table Of Contents

There are **not** similar commands for sections and subsections as these are not specified in the MSU style guide.

## THEORY

Equations

Here is an example of an equation

$$a^2 + b^2 = c^2, \tag{2.1}$$

which states the square of the hypotenuse  $c$  of a triangle is equal to the sum of the square of the other two sides ( $a$  and  $b$ ).

A collection of similar equations can be written using the `\align` environment, e.g.,

$$\sin(\theta) = \frac{1}{\csc(\theta)} \tag{2.2}$$

$$\cos(\theta) = \frac{1}{\sec(\theta)} \tag{2.3}$$

$$\tan(\theta) = \frac{1}{\cot(\theta)} \tag{2.4}$$

Cases can be added using

$$x = \begin{cases} y, & \text{if } t = 1; \\ z, & \text{otherwise.} \end{cases} \tag{2.5}$$

Symbols

Symbols, like greek letters, can be used in equations, e.g.,  $\theta$ ,  $\gamma$ , and  $\zeta$ . When variables are referenced in the text they should be written in mathmode and enclosed in dollar signs. For example,  $a$  and  $\text{a}$ , which are written in math and text modes, respectively.

## Figures

Figures can easily be added to your latex document. Graphs and figures should be designed to be printed in black and white and clearly display information. Considering using vectorized graphics that will remain sharp even if viewed zoomed (try zooming on Fig 2.1). The text in your figure should be legible and preferably the same size as the text in the rest of your document.

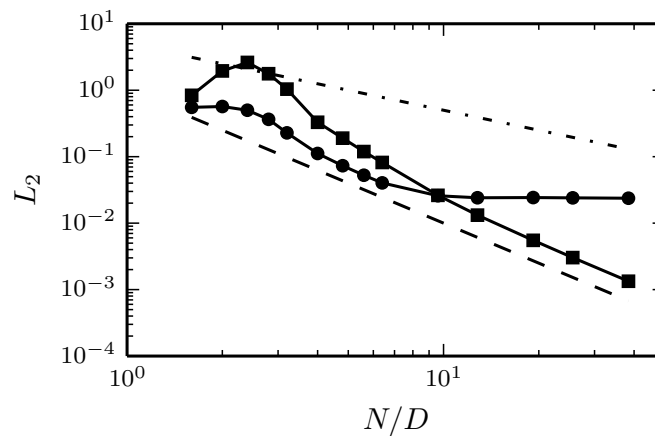


Figure 2.1: This is a figure of some data.

In  $\text{\LaTeX}$  figures may float and move around to a location that is optimized using mathematics. The `htbp` in the definition of the figure environment means here, top, bottom, page and is the order of preference for where the figure goes.

Figure 2.2 shows you can also put pictures into  $\text{\LaTeX}$  documents. The size of the figure is controlled by adjusting width. If you find your figures are often floating to a page of their own consider changing their size and/or adding more text.

Figure 2.3 shows that you can create figures directly within your  $\text{\LaTeX}$  document using, for example, the `tikz` package.



Figure 2.2: Montana Hall on Montana State University's campus.

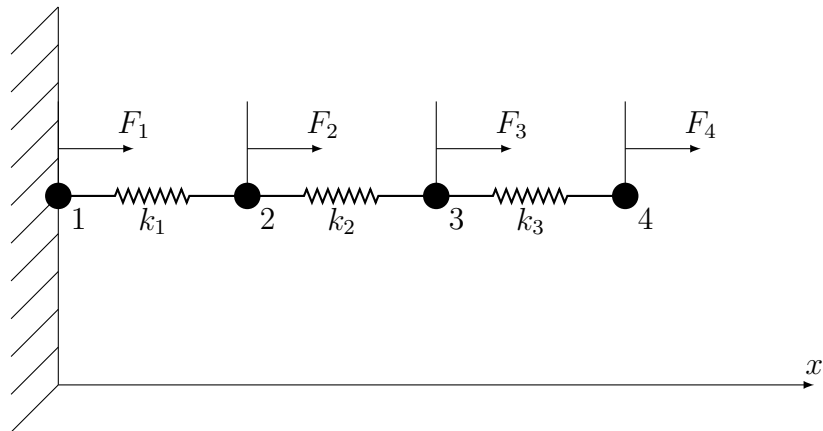


Figure 2.3: Figure created using the tikz package.



Figure 2.4: Figure forced to be on page by itself.



## Tables

Tables can be created directly in your  $\text{\LaTeX}$  document. Table 2.1 shows how a short caption can be used in the table of contents and a long caption in the figure. In the table of contents “Area of ice sheet” is listed and above the table “Area of ice sheet in millions of square miles with time.” is shown. This is done by adding an optional argument to the `\caption` command, i.e., `\caption[Short Caption]{Long Caption}`.

Table 2.1: Area of ice sheet in millions of square miles with time.

Year	1985	1990	1995	2000	2005	2010	2015
Area	16.2	15.5	15.2	15.5	14.6	15.4	14.5

## Algorithms

Algorithms can be added using the algorithmic environment as shown in Algorithm 2.1.

## References and Citations

### Referencing other parts of the document

Equations, figures, tables, sections, and chapters can be references using the `\ref{label}` command. For example, `\ref{fig:plot}` references Fig. 2.1.

You can also use the `\vref` command to also get the page number. For example, `\vref{fig:plot}` references Fig. 2.1 on page 4.

The `label` used in the `\ref` command can be anything you want to use. It is helpful to use a convention. For example, all figures could have a label that starts

```

1: Input: Function  $f$  to optimize, subpopulations  $\mathcal{S}$ 
2: Output: Full global solution  $\mathbf{G}$ 
3: // Iterate over random permutation of  $\mathbf{X}$ 
4: for each  $X_i \in \mathbf{X}$  do
5:   // Initialize comparison variables
6:    $bestFit \leftarrow \infty$ 
7:    $bestVal \leftarrow \mathbf{S}_0[X_i]$ 
8:   // Iterate over random permutation of  $\mathcal{S}$ 
9:   for each  $\mathbf{S}_j \in \mathcal{S}$  where  $X_i \in \mathbf{S}_j$  do
10:    // Substitute subpopulation component into full global solution
11:     $G_i \leftarrow \mathbf{S}_j[X_i]$ 
12:    // Compare Fitness
13:    if  $f(\mathbf{G})$  is better than  $bestFit$  then
14:       $bestVal \leftarrow \mathbf{S}_j[X_i]$ 
15:       $bestFit \leftarrow f(\mathbf{G})$ 
16:    endif
17:  endfor
18:  // Copy  $bestVal$  into full global solution
19:   $G_i \leftarrow bestVal$ 
20: endfor
21: return

```

Algorithm 2.1: Algorithm example

with `fig:` and all table labels could start with `tab:`.

### Citing others work

Citing others work is an important aspect of all scientific writing. All citations should be placed in the .bib file(s) listed in your main.tex document. Cite others work using the `\cite` command, e.g., [?]. Multiple citations should be done within one cite command, e.g., [?, ?, ?].

## CONCLUSION

$\text{\LaTeX}$  produces documents that look great, automatically handles references and citations, and easily incorporates figures and tables. This is not a guide to  $\text{\LaTeX}$  but rather an introduction to the MSU style. If you want more information about  $\text{\LaTeX}$  many introductory guides can be found online.

## APPENDIX: EXAMPLE CODE

This work used the following MATLAB code to produce basically nothing. But, I'll include it here for the sake of an example.

```
% MATLAB code to say 'hello world'  
disp('Hello world')
```