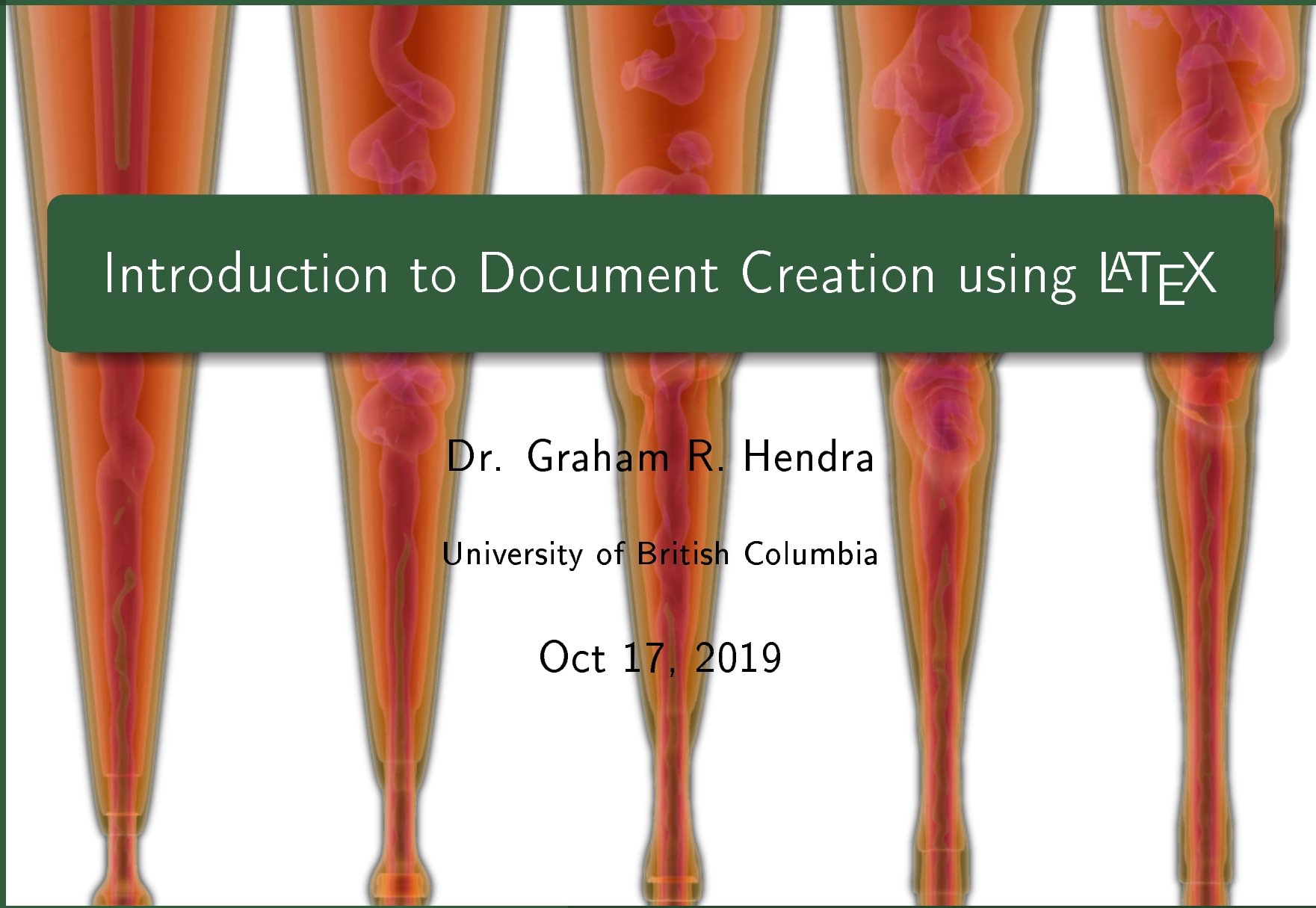

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Introduction to Document Creation using LaTeX

Dr. Graham R. Hendra

University of British Columbia

Oct 17, 2019

Why Use LaTeX ?

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Pros:

- Good for writing formulas
- Allows focus on structure, rather than formatting
- Good for cross-references and citations
- Visually impressive documents
- PDF output — no updates on printing

Cons:

- Larger initial time investment
- Awkward table creation mechanism
- Paradigm works against you if you're interested in implementing a specific format
- Can be harder to track changes between versions of a document

LaTeX vs Word Processors

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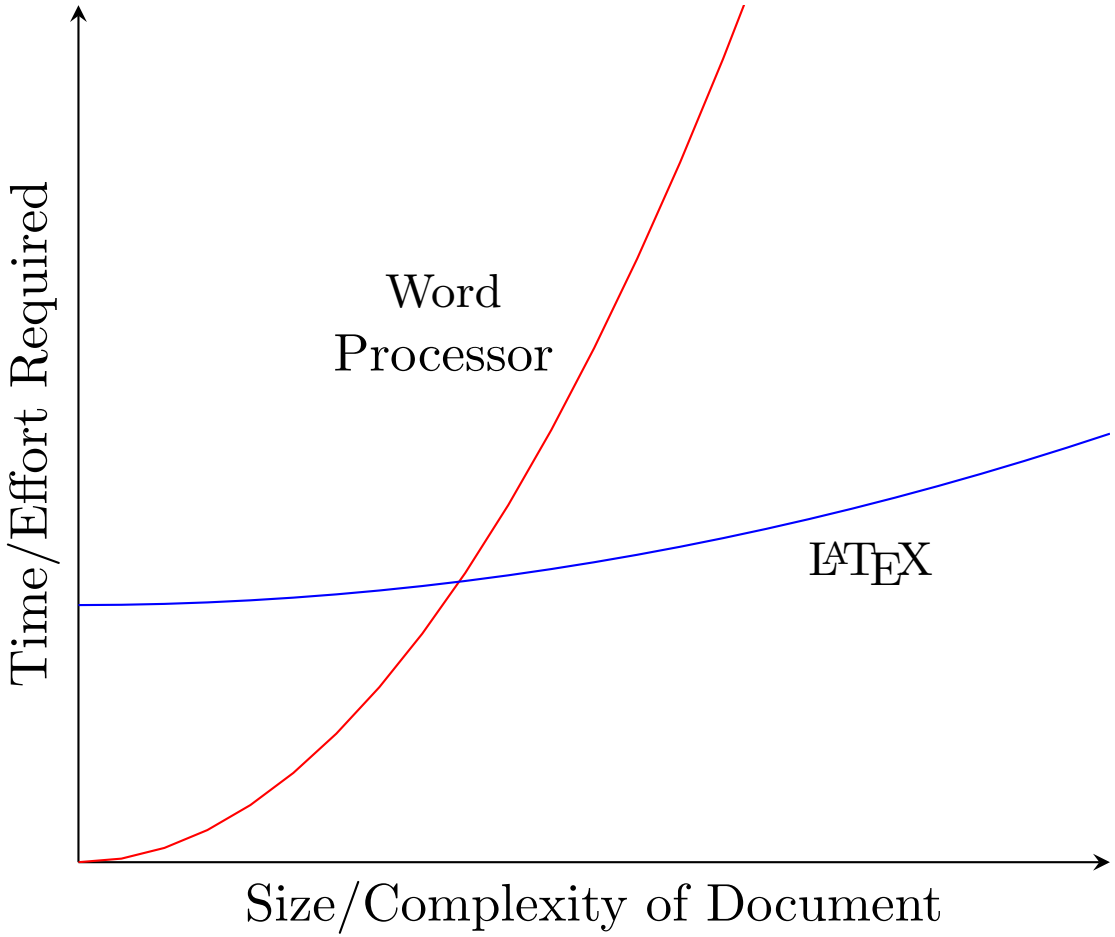

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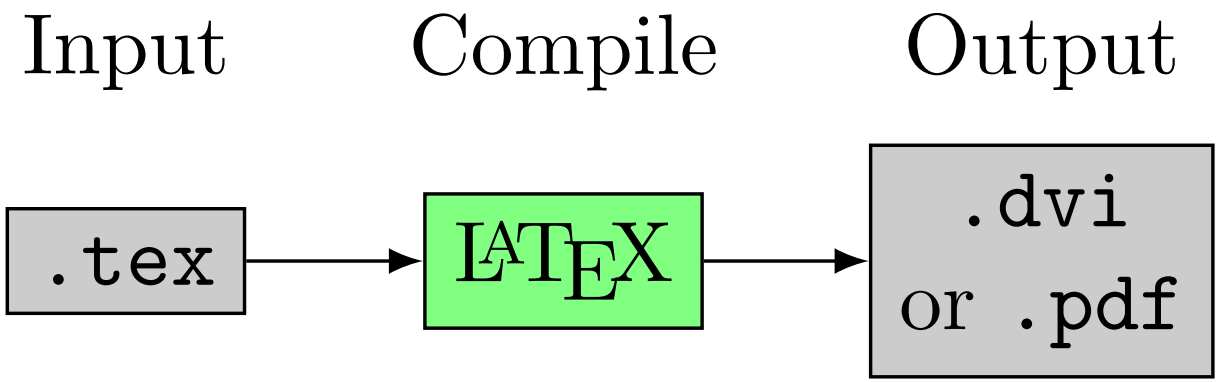

1. Document structure coded in a `.tex` source file
   - Plain text file; can be modified using any editor
   - Formatting is accounted for by a single statement at the beginning of the document
2. Source file compiled to a `.dvi` or `.pdf` file
   - `.pdf` files are typically the final product

Tools

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1. The LaTeX compiler
   - Contains all the fundamental functionality for converting `.tex` files to `.dvi` or `.pdf` files
2. Package Extensions
   - Add new functionality to LaTeX or change existing options
3. A LaTeX Editor
   - Provides a good environment for editing `.tex` files
     - Autocompletion of recognized commands
     - Simple interface for compiling and viewing documents

Installation: LaTeX Compiler

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- Windows:
  - I recommend MiKTeX from `http://miktex.org/download`
- Linux:
  - Often pre-installed
  - If not available, `$ sudo apt-get install texlive`
- Mac:
  - Install MacTeX from `http://www.tug.org/mactex/`

Installation: Packages and LaTeX Editor

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Packages:

- Most packages are installed with the compiler
- MiKTeX will automatically install missing packages

Editor:

- Texmaker (`http://www.xm1math.net/texmaker/download.html`) is available for all three major operating systems

"Hello World!" Example

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- An annotated version of the complete file will be provided to you after the tutorial
- Remember to think for yourself!! ☺
  - It's not magic
  - Normal problem-solving techniques still apply

Reserved Symbols

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Reserved	Code for Character Literal
#	\#
$	\$
%	\%
^	\textasciicircum
&	\&
_	_
{ }	\{ \}
[ ]	{[} {]}
~	\~{ }
\	\textbackslash

Non-Printing Symbols

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Not Printed from Source		LaTeX Code	
“	(opening double quote)	``	(two grave accents)
”	(closing double quote)	''	(two apostrophes)
—	(em dash)	---	(three hypens)

In addition, the characters $<$ and $>$ will only display in math mode

LaTeX Classes

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Default Classes (installed with the compiler)

- `article`: for scientific articles
- `report`: for longer reports containing chapters (e.g. theses)
- `book`: for long documents; similar to report, but contains `frontmatter`, `mainmatter`, and `backmatter` and does not contain an `abstract` environment
- `letter`: for letters
- `beamer`: for slideshows (like this one!)
  - Note: the LaTeX-vs-alternatives comparison is less favourable for presentations (LaTeX presentations are about as hard to prepare as PowerPoint presentations)

Sectioning Levels

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Command	Level	Availability
\part{}	-1	Article, Book, Report
\chapter{}	0	Book, Report
\section{}	1	Article, Book, Report
\subsection{}	2	Article, Book, Report
\subsubsection{}	3	Article, Book, Report
\paragraph{}	4	Article, Book, Report
\subparagraph{}	5	Article, Book, Report

Equation Examples

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Fluid Mechanics:

$$\rho\left(\frac{\partial\vec{v}}{\partial t}+\vec{v}\cdot\vec{\nabla}\vec{v}\right)=-\vec{\nabla}p+\vec{\nabla}\cdot\overline{\overline{\mathbb{T}}}+f \tag{1}$$

$$\overline{\overline{\mathbb{T}}}=\begin{pmatrix}\sigma_x-P & \tau_{xy} & \tau_{xz}\\ \tau_{yx} & \sigma_y-P & \tau_{yz}\\ \tau_{zx} & \tau_{zy} & \sigma_z-P\end{pmatrix} \tag{2}$$

General Relativity:

$$G_{\mu\nu}\equiv R_{\mu\nu}-\frac{1}{2}Rg_{\mu\nu} \tag{3}$$

$$G_{\mu\nu}+g_{\mu\nu}\Lambda=\frac{8\pi G}{c^4}T_{\mu\nu} \tag{4}$$

Most Common Equation Environments

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Environment	Lines	Eqn #'s	Aligned?
`equation`	1	1	No
`align`[1]	1+	1/line	Yes
`aligned`[1] in `equation`	1+	1	Yes

[1] Requires the `amsmath` package

For *un*-numbered math blocks, use `align*` (`equation*` is also an option, if you don't need multiple lines or alignment)

The cancel Package

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Fraction Cancellation:

$$\begin{aligned} a &= 4 + \frac{7x}{x^2} \\ &= 4 + \frac{7\cancel{x}}{x\cancel{^2}} \\ &= 4 + \frac{7}{x} \end{aligned} \tag{5}$$

Substitution:

$$\theta = h + \cancelto{0}{ke} + \cancelto{0}{pe} \tag{6}$$

The siunitx Package

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Number printing:

- `\num{123456.78901}` → 123 456.789 01
- `\num{5e18}` → 5×10^{18}

Units and unit-carrying values:

- `\si{J\per kg\per K}` → J/kg/K
- `\SI{9.81}{m\per s\squared}` → 9.81 m/s^2
- `\SI[per-mode=symbol]{9}[\$]{\per kg}` → \$9 /kg
- `\SI{28}{\celsius}` → 28 °C

Angles:

- `\ang{60}` → 60°
- `\ang{1;2;3}` → 1°2′3″

The same commands can also be used in math mode

The hyperref Package

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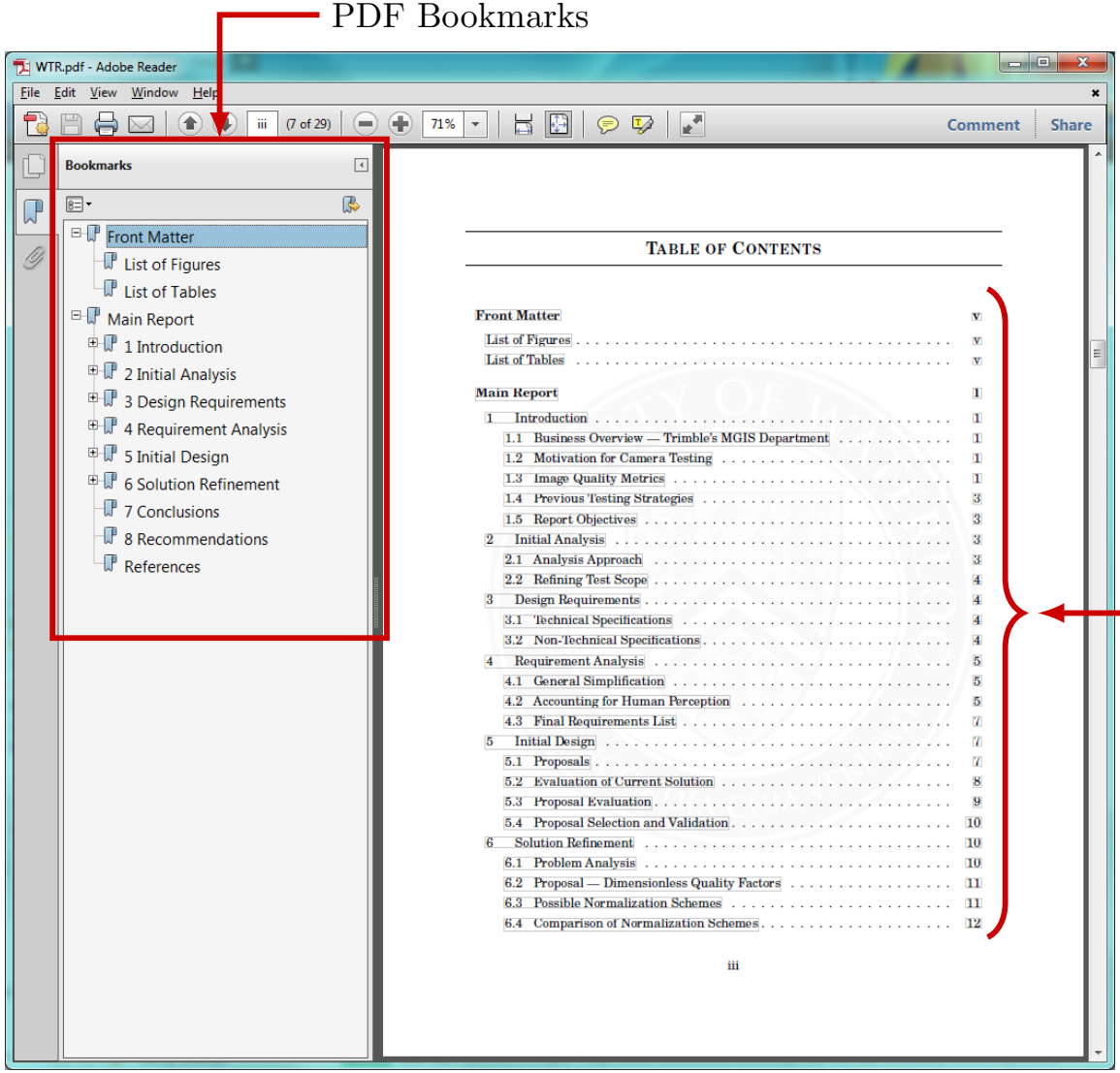

The fancyhdr Package

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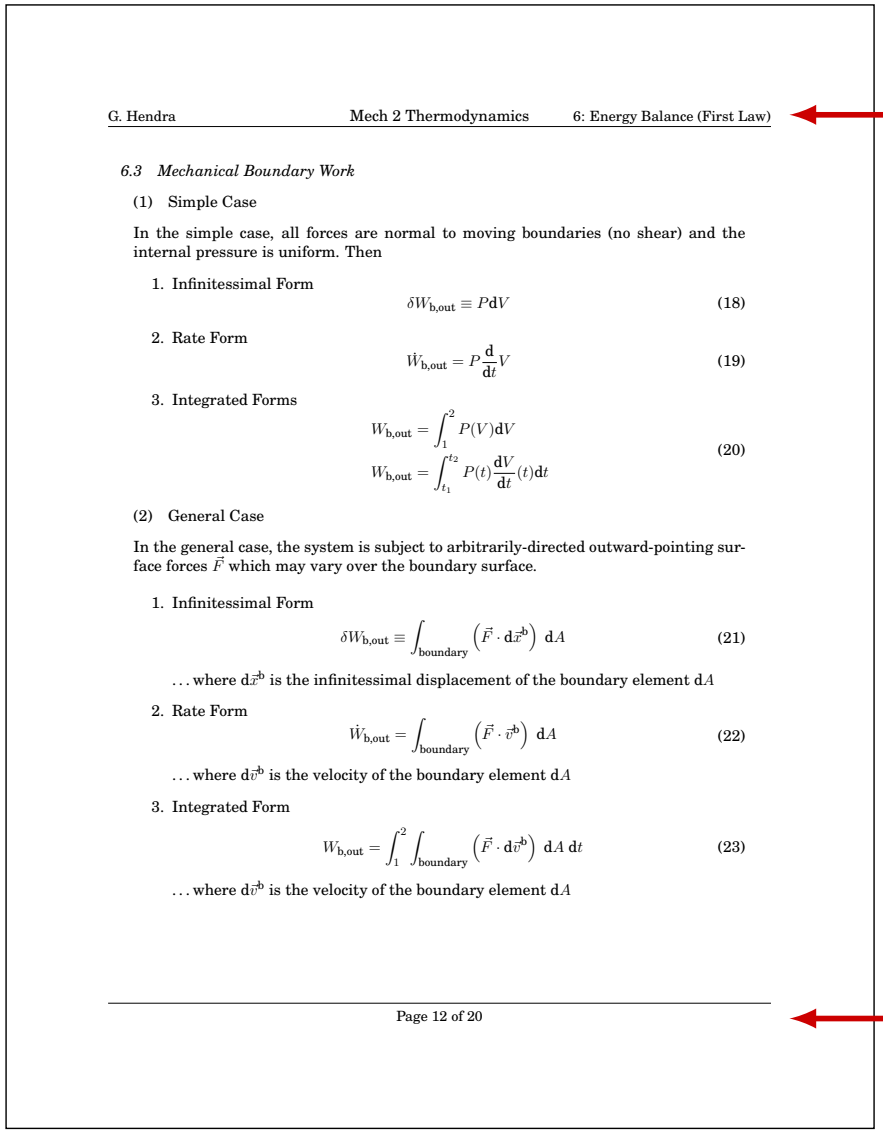

G. Hendra Mech 2 Thermodynamics 6: Energy Balance (First Law)

6.3 Mechanical Boundary Work

(1) Simple Case

In the simple case, all forces are normal to moving boundaries (no shear) and the internal pressure is uniform. Then

1. Infinitessimal Form

$$\delta W_{\text{b,out}} \equiv P\mathrm{d}V \tag{18}$$

2. Rate Form

$$\dot{W}_{\text{b,out}} = P\frac{\mathrm{d}}{\mathrm{d}t}V \tag{19}$$

3. Integrated Forms

$$\begin{aligned} W_{\text{b,out}} &= \int_1^2 P(V)\mathrm{d}V \\ W_{\text{b,out}} &= \int_{t_1}^{t_2} P(t)\frac{\mathrm{d}V}{\mathrm{d}t}(t)\mathrm{d}t \end{aligned} \tag{20}$$

(2) General Case

In the general case, the system is subject to arbitrarily-directed outward-pointing surface forces $\vec{F}$ which may vary over the boundary surface.

1. Infinitessimal Form

$$\delta W_{\text{b,out}} \equiv \int_{\text{boundary}} \left(\vec{F}\cdot \mathrm{d}\vec{x}^{\text{b}}\right)\,\mathrm{d}A \tag{21}$$

...where $\mathrm{d}\vec{x}^{\text{b}}$ is the infinitessimal displacement of the boundary element $\mathrm{d}A$

2. Rate Form

$$\dot{W}_{\text{b,out}} = \int_{\text{boundary}} \left(\vec{F}\cdot \vec{v}^{\text{b}}\right)\,\mathrm{d}A \tag{22}$$

...where $\mathrm{d}\vec{v}^{\text{b}}$ is the velocity of the boundary element $\mathrm{d}A$

3. Integrated Form

$$W_{\text{b,out}} = \int_1^2 \int_{\text{boundary}} \left(\vec{F}\cdot \mathrm{d}\vec{v}^{\text{b}}\right)\,\mathrm{d}A\,\mathrm{d}t \tag{23}$$

...where $\mathrm{d}\vec{v}^{\text{b}}$ is the velocity of the boundary element $\mathrm{d}A$

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Running Header

Running Footer

The subcaption Package

(a) A gull

(b) A tiger

Figure: Animals

Easier Table Creation

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Table creation is probably the most tedious part of creating LaTeX documents, but fortunately there are plugins for spreadsheet programs which can convert a set of cells into LaTeX code:

- **For Microsoft Excel:** Excel2LaTeX (`http://www.ctan.org/tex-archive/support/excel2latex/`)
- **For OpenOffice Calc:** Calc2LaTeX (`http://calc2latex.sourceforge.net/`)

Customization

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It's fairly straightforward to tweak things like

- which section levels appear in the Table of Contents
- the numeral style (arabic, roman, alphabetic)
- the numbering scheme (e.g. number figures within sections: 1-1, 1-2, . . . ; 2-1, 2-2, . . .)

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- The LaTeX Wikibook (`http://en.wikibooks.org/wiki/LaTeX`) has a great overview of pretty much everything
- Googling "Latex [what you're trying to do]" will typically direct you to a forum where someone has already asked your exact question and received several answers.
  - TeX Stack Exchange (`http://tex.stackexchange.com/`) will probably be a frequent top hit. You can also ask your own questions on the site if they aren't already answered
- Most packages come with a manual file named `[packagename].pdf`
- `http://detexify.kirelabs.org/classify.html` — draw a symbol and the website will tell you how to code it in LaTeX

References with BibTeX

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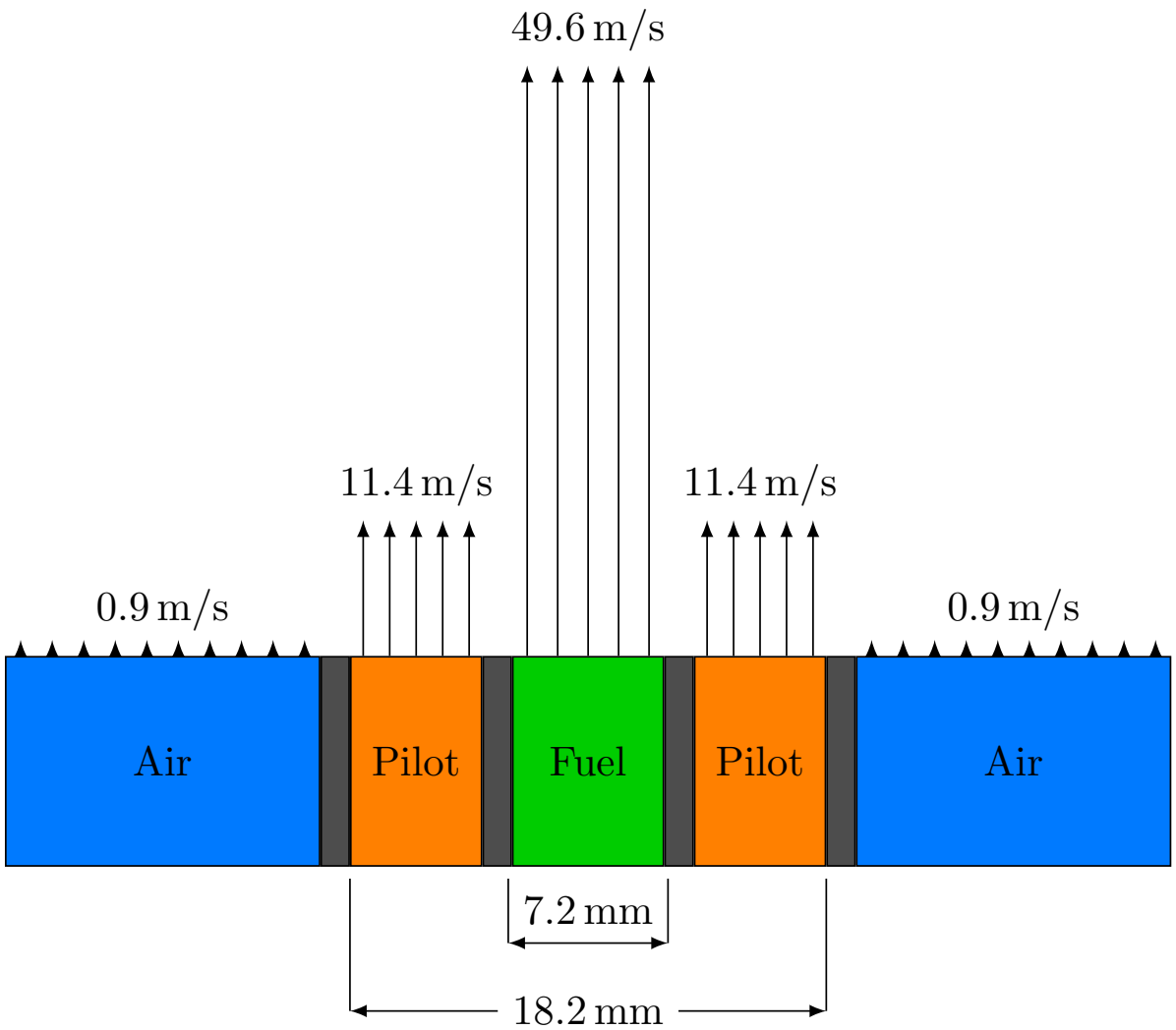
Process		
Substance	Conditions	n
Any	Isobaric (const. P)	0
Ideal Gas	Isothermal (const. T)	1
Ideal Gas with const. c_p, c_v	Isentropic (const. s)	$\gamma \equiv \frac{c_\mathrm{p}}{c_\mathrm{v}}$
Any	Isochoric (const. V)	∞



Diagrams with TikZ

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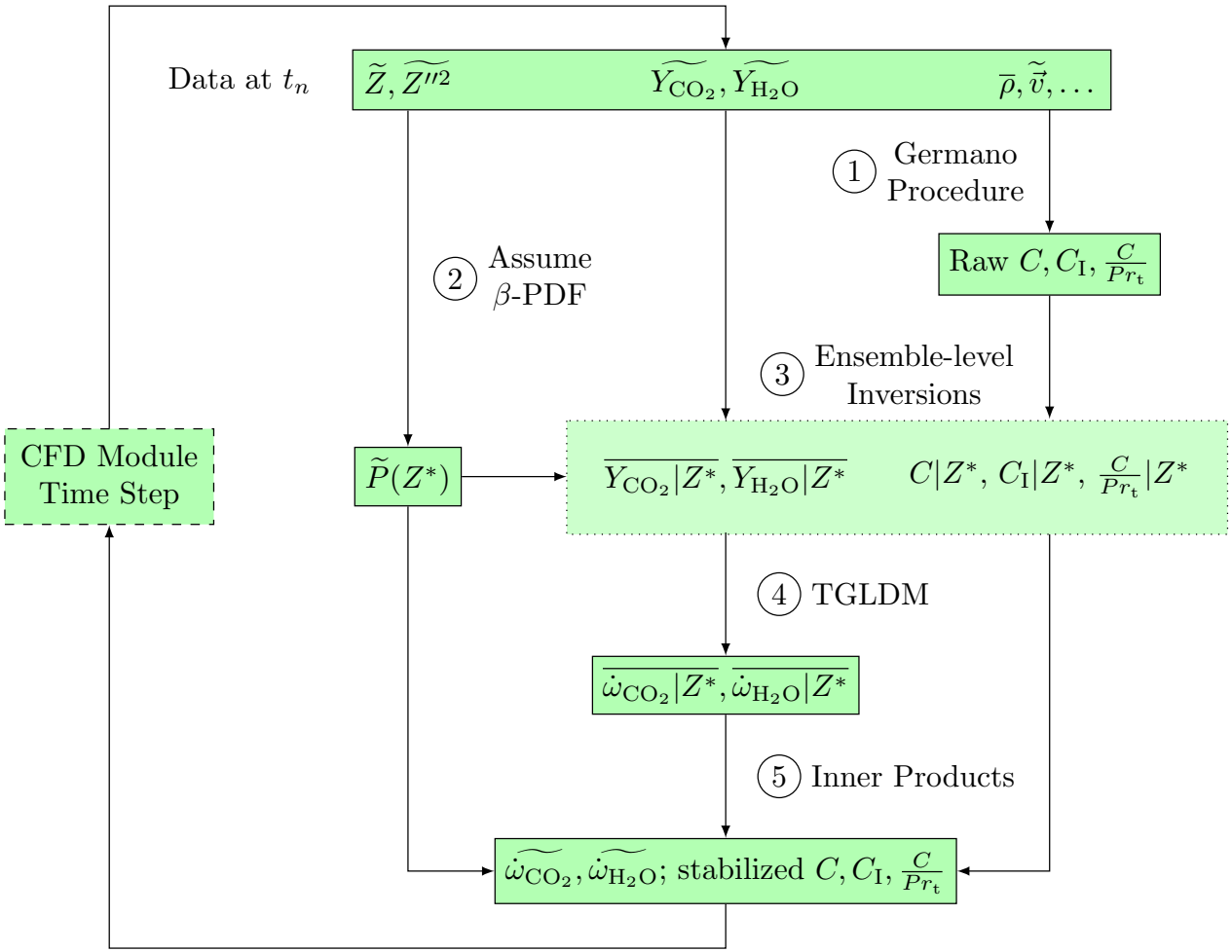
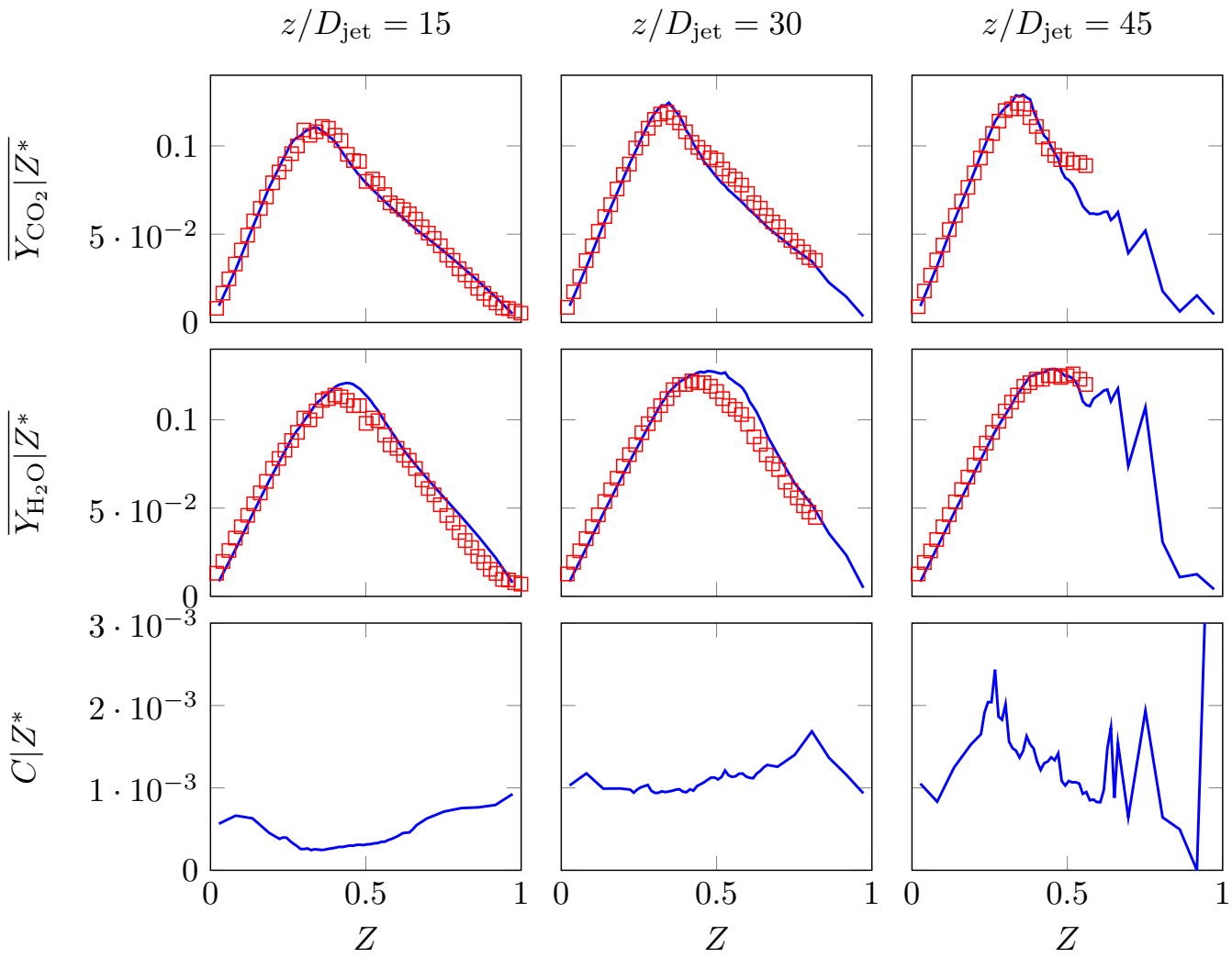
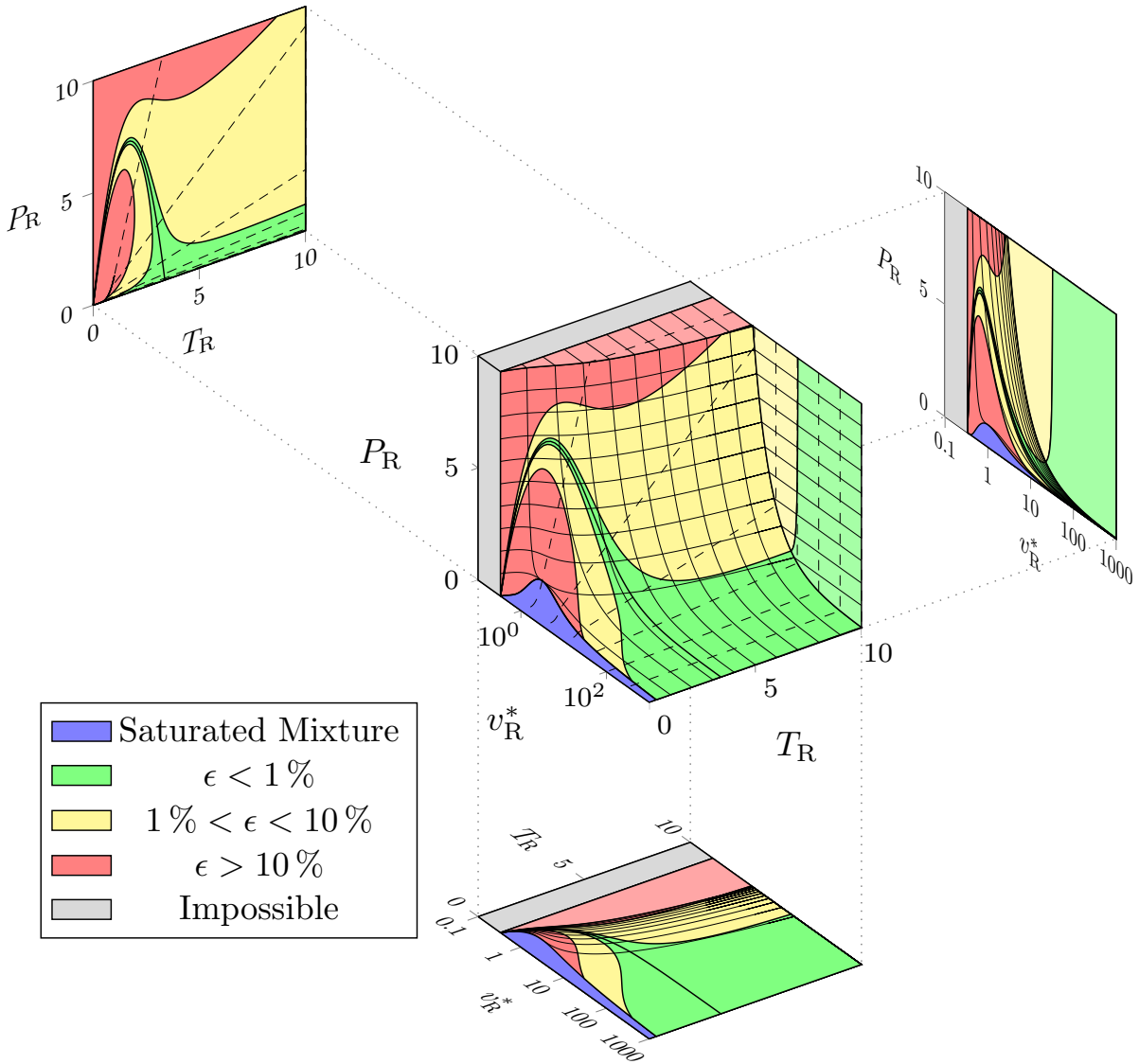


Graphs with PGFPlots



Graphs with PGFPlots



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Customizing Table of Contents Entries

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- Not all levels appear in the Table of Contents. The deepest level to appear can be changed by modifying the counter `tocdepth`; for example, to make only sections appear:

```
\setcounter{tocdepth}{1}
```

- Each sectioning command has a corresponding "starred" version (e.g. `\section*{}`) which creates a heading but does not number it or place it in the Table of Contents
- Items which are not inserted into the Table of Contents by default can be added using

```
\addcontentsline{[table]}{[sectionname]}{[title]}
```

`[table]` = `toc`, `lof`, or `lot`
`[sectionname]` = part, chapter, section...
`[title]` is the text of the entry (e.g. "References")

Line Breaking

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Automatic breaking at words

- LaTeX is generally good at identifying acceptable hyphenation points in English words
- If LaTeX has difficulty, the code `\-` can be inserted within a word to indicate that LaTeX may break the word at this location if necessary (e.g. `man\-u\-script`). This has no impact if the word falls in the middle of a line.

Breaking at spaces

- The tilde (~) represents a non-breaking space

Breaking at slashes

- The slash literal (/) is never used as a line break point
- The LaTeX code `\slash` is a slash which is allowed to be used as a line break point

Inter-Word vs. Inter-Sentence Spacing

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LaTeX usually treats any combination of whitespace characters as identical to a single space; the size of the space inserted is determined by context:

- Default: inter-word (standard) space
- Following a period: inter-sentence space (slightly larger)
  - *unless* the character before the space is a capital letter (typically indicating an initial or initialism)

In corner cases, this will be wrong:

- Lower-case short forms (such as "vs.") are treated as the end of a sentence. In this corner case the escaped space (`\ `) can be used to force an inter-word space
- Words which end in capitals are treated as initials if they fall at the end of a sentence (e.g. "...with NASA."). In this corner case using the escaped period (`\@.`) can be used to indicate that a sentence has ended

Dashes

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Professional typesetters actually makes a distinction between different varieties of dashes:

Character	Name	Code	Usage
−	Minus Sign	$-$	in math environments
-	Hyphen	-	within words
–	en (n) dash	--	within ranges (eg. pages 4–27)
—	em (m) dash	---	interruption within a sentence

(The en and em dash are so called because their widths are comparable to the widths of those letters)