Portable Ultrasound System for Blood Velocity Estimation
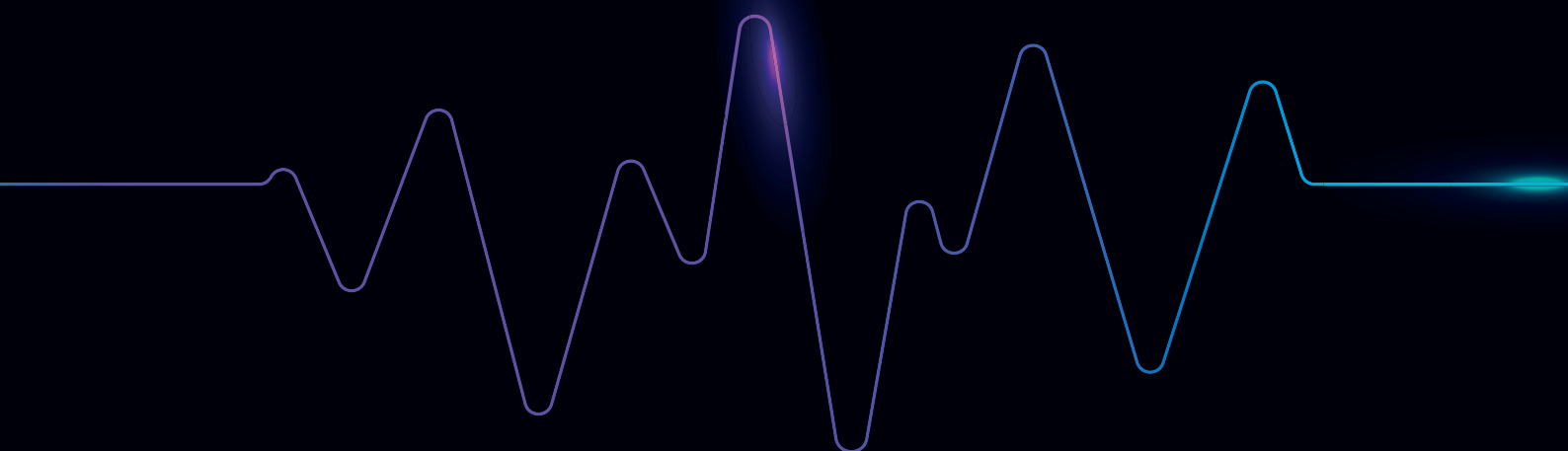
Jeppe Hinrichs

Master Thesis

Portable Ultrasound System for Blood Velocity Estimation
Project Report

Master Thesis
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Approval

This thesis has been prepared over six months at the Brain/Biomedical Microsystems Laboratory, School of Electrical Engineering, at the Korean Advanced Institute of Science and Technology, KAIST, and the Department of Electrical Engineering, Technical University of Denmark, DTU. This thesis is in partial fulfilment for the joint-degree Master of Science in Electrical Engineering, MSEE from KAIST and DTU.

It is assumed that the reader has a basic knowledge in the areas of electrical engineering and circuit analysis.

Jeppe Hinrichs - s163555

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Signature

....
Date

Abstract

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Contents

Portable Ultrasound System for Blood Velocity Estimation

List of Figures

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Acronyms

Notation	Description
AC	Alternating Current. 2
DC	Direct Current. 2
GCD	Greatest Common Divisor. 2
HIGH	Logic high voltage level. 2
LCM	Least Common Multiple. 2
LOW	Logic low voltage level. 2
MOSFET	Metal-Oxide-Semiconductor Field-Effect Transistor. 2
SPICE	Electronic circuit simulator.. 2

Glossary

Notation	Description
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Portable Ultrasound System for Blood Velocity Estimation

1   Introduction

This template complies with the DTU Design Guide https://www.designguide.dtu.dk/. DTU holds all rights to the design program including all copyrights. It is intended for two-sided printing. The `\cleardoublepage` command can be used to ensure that new sections and the table of contents begins on a right-hand page. The back page always ends as an odd page.

All document settings have been collected in Setup/Settings.tex. These are global settings, meaning the settings will affect the whole document. Defining the title for example will change the title on the front page, the copyright page, and the footer. A watermark can be enabled or disabled in Setup/Premeable.tex. You can edit the watermark to display draft, review, approve, confidential, or anything else. By default, the watermark is printed on top of the document's contents and has a transparent gray color. Here I am just testing the synchronization functionality of Overleaf and Github. Now, that the first synchronization finished successfully, I want to test that the reverse direction process is also functional. Hopefully, this will end up on Overleaf.

1.1   This is a section

Every chapter is numbered and the sections inherit the chapter number followed by a dot and a section number. Figures, equations, tables, etc. also inherit the chapter numbering.

1.1.1   This is a sub section

Sub-sections are also numbered. In general, try not to use a deep hierarchy of sub-sections (`\paragraph{}` and the like). The document will become segmented, which will make the document appear less coherent.

This is a sub sub section

And those are not numbered. It is possible to adjust the deep hierarchy of numbering sections in Setup/Settings.tex.

The front and back cover has been made to replicate the examples in the design guide https://www.designguide.dtu.dk/#stnd-printmedia. The name of department heading is omitted because it is located in the top right corner (no need to write it twice). Take a look at https://www.inside.dtu.dk/en/medarbejder/om-dtu-campus-og-bygninger/kommunikation-og-design/skabeloner/rapporter if you want to make your cover separately.

Citing is done with the `biblatex` package [1]. Cross referencing (figures, tables, etc.) is taken care by the `cleveref` package. Just insert the name of the label in `\cref{}` and it will automatically format the cross-reference. For example, writing the `cleveref` command `\cref{fig:groupedcolumn}` will output "fig. 3.3". Using `\Cref{}` will capitalize the first letter and `\crefrange{}{}` will make a reference range. An example: Figure 3.2 is an example of a stacked bar chart and figs. 3.1 to 3.3 are three consecutive figures.

1.2   Font and symbols test

Symbols can be written directly in the document, meaning that there is no need for special commands to write special characters. I love to write special characters like æøå inside my T$_E$X document. Also á, à, ü, û, ë, ê, î, ï could be nice. So what about the "¿" character. What about ° é ® † ¥ ü | œ ' @ ö ä ¬ ‹ « © ƒ ß ª … ç ñ µ , · ¡ " £ ™ [ ] '. Some dashes - – —, and the latex form - – —

This is a font test
Arial Regular
Arial Italic
Arial Bold
Arial Bold Italic

Given a set of numbers, there are elementary methods to compute its Greatest Common Divisor, which is abbreviated GCD. This process is similar to that used for Least Common Multiple (LCM).

I want to talk about SPICE, HIGH and LOW. These are all DC and AC electric principles. I want to mention that Metal-Oxide-Semiconductor Field-Effect Transistor devices can be called MOSFET.

2 Colours

The design guide define 3 primary colours (dtured, white and black) and 10 secondary colours https://www.designguide.dtu.dk/#stnd-colours. Below are codes for the various colour modes. RGB is used for web and Office Programmes. CMYK is used for print. HTML is used for HTML-coding. If you know anything about colour codes you might notice that the RGB codes are ranging from 0-1 instead of the usual 0-255.

color	rgb	cmyk	HTML
dtured	0.77 0 0.05	0 0.91 0.72 0.23	C4000D
white	1 1 1	0 0 0 0	FFFFFF
black	0 0 0	0 0 0 1	000000
blue	0.12 0.24 1	0.88 0.76 0 0	1F3DFF
brightgreen	0.31 1 0.34	0.69 0 0.66 0	4FFF57
navyblue	0 0 0.4	1 0.9 0 0.6	000066
yellow	0.95 0.83 0.18	0.05 0.17 0.82 0	F2D42E
orange	1 0.35 0.14	0 0.65 0.86 0	FF5924
pink	1 0.65 0.74	0 0.35 0.26 0	FFA6BD
red	1 0.14 0.35	0 0.86 0.65 0	FF2459
green	0 0.78 0	0.89 0.05 1 0.17	00C700
purple	0.33 0.04 1	0.67 0.96 0 0	540AFF

The default colour mode for this template is cmyk. The current colour model is cmyk which is also illustrated by the underlined numbers in the colour test table above. If you which to change the colour model to rgb go to Setup/Settings.tex and change targetcolourmodel to rgb. In Setup/Settings.tex it is also possible to change the background colour of the front and back page. The colours are primarily used for diagrams (the plotcyclelist DTU) and the front and back page.

Lighter colours can be achieved as written in the LATEX code below. For example to get a tint of 50% you would write colourname!50.

Normal dtured   80% dtured   70% dtured   60% dtured   50% dtured

For more information about colours in LATEX read the xcolor manual.

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3 Examples of figures, tables, equations and listings

In the following a bunch of examples of figures and tables have been made. There are advantages to using `tikZ` diagrams over excel diagrams. 1) the font and font size perfectly matches the document 2) the styling and colours are pre-defined to follow the design guide 3) the plots uses vector graphics which reduces the file size, reduces the compile time and looks sharp when zooming in. The possibilities are endless, look at the `pgfplots` gallery for inspiration: `http://pgfplots.sourceforge.net/gallery.html`. However there are still cases where I would recommend to insert a plot as a picture. For example if the plot contains a lot of data: a line graph with 1000 points takes a long time to compile.

Some tips if you want good looking diagrams or graphs which will be inserted as pictures (e.g. in a figure environment with \includegraphics): The main font is Arial. Use DTU colours as described in chapter 2. Use high quality pictures. Try to scale the diagram (picture) so the text size of the axis legends match the text size in this document.

Remember to change the label of your figures so there are no duplicate labels. A label should be placed below a caption or after a heading (fx after a \chapter).

3.1 Graphs and charts
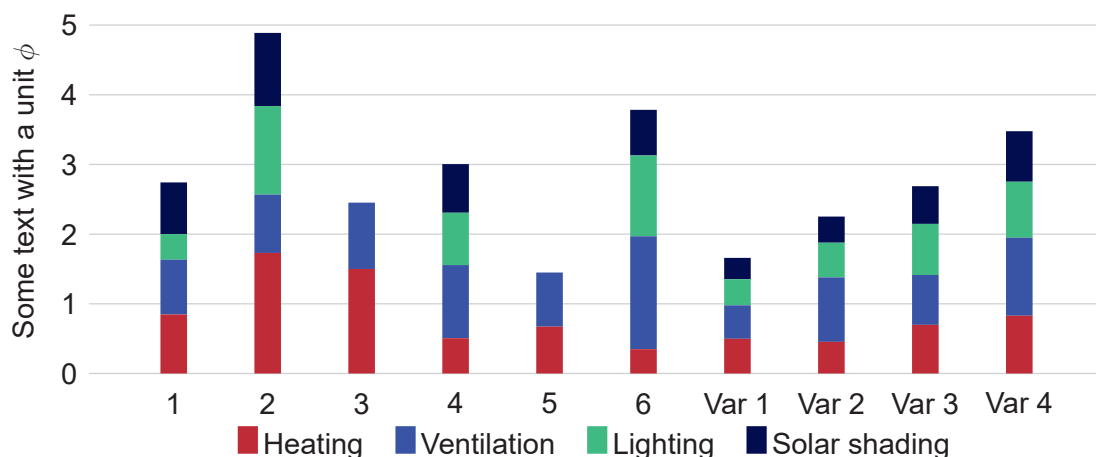
Figure 3.1: Stacked column chart
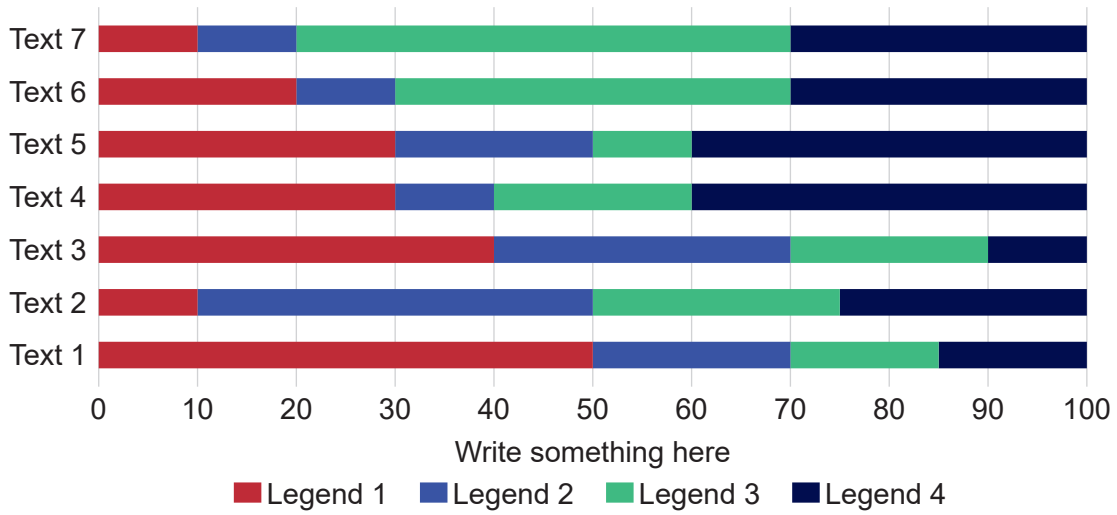
Figure 3.2: Stacked bar chart
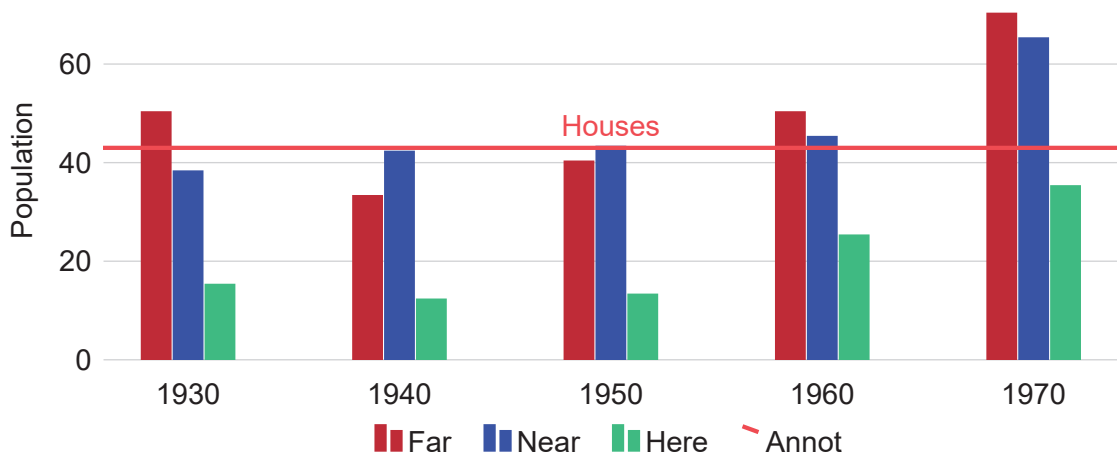
Figure 3.3: Grouped column chart

Figure 3.4: Line graph

Portable Ultrasound System for Blood Velocity Estimation
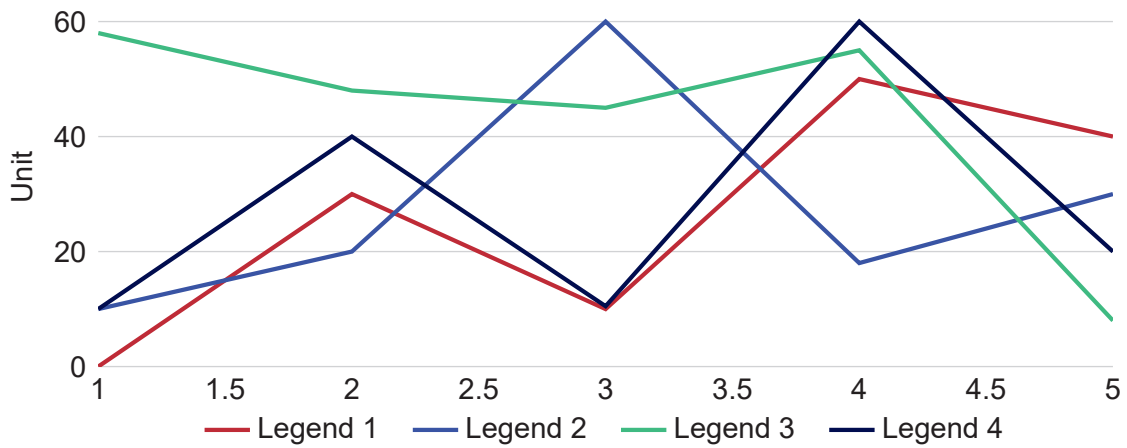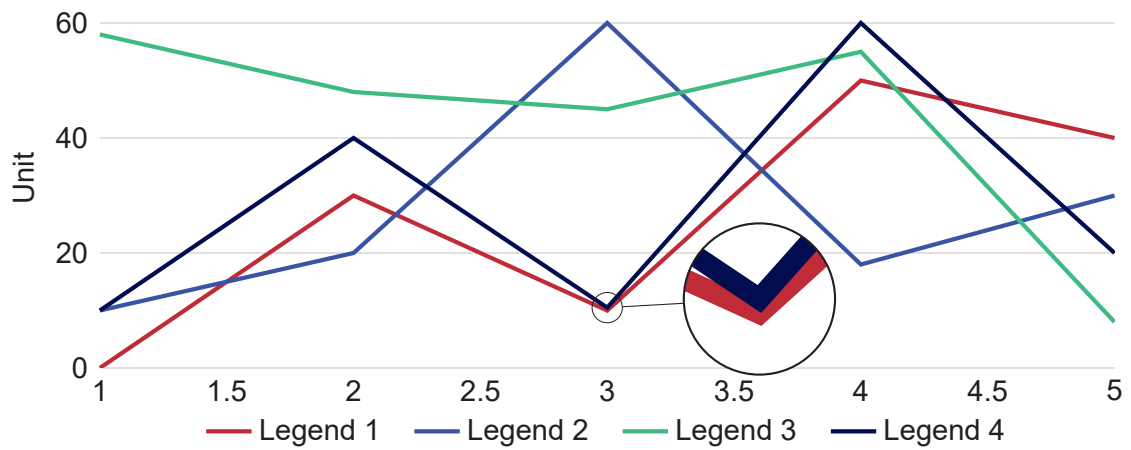
Figure 3.5: Line graph with magnifying glass
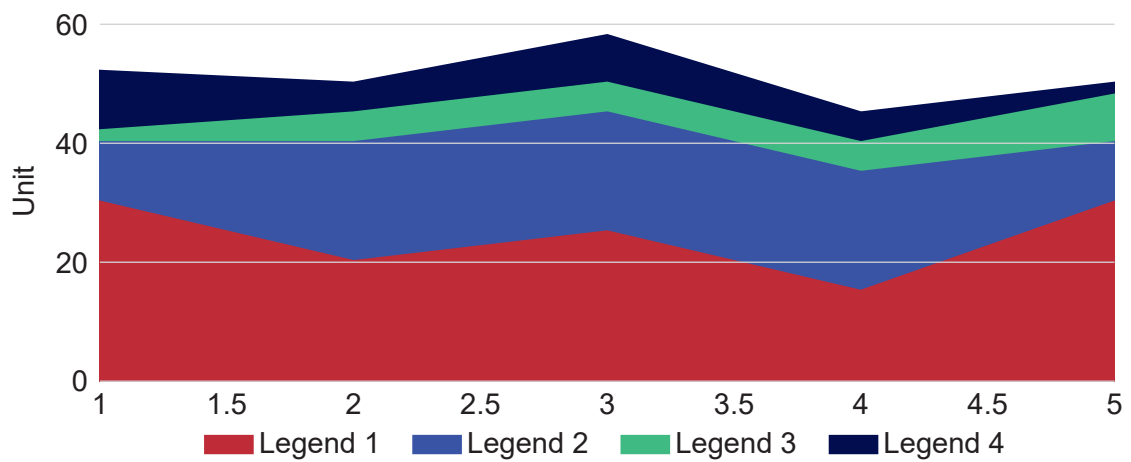
Figure 3.6: Area graph
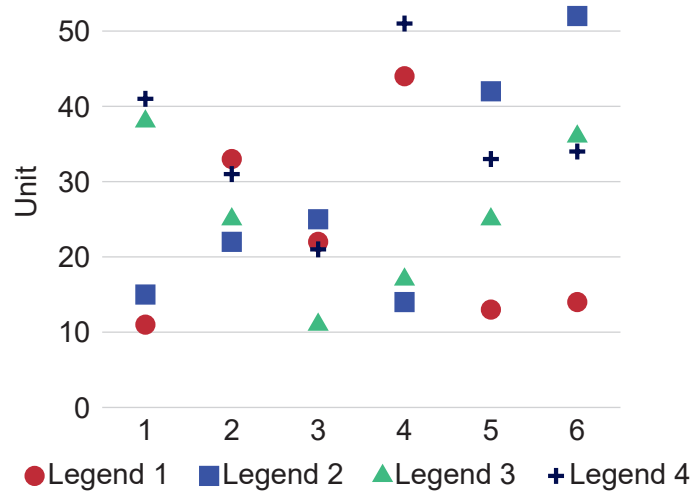
Figure 3.7: Scatter plot
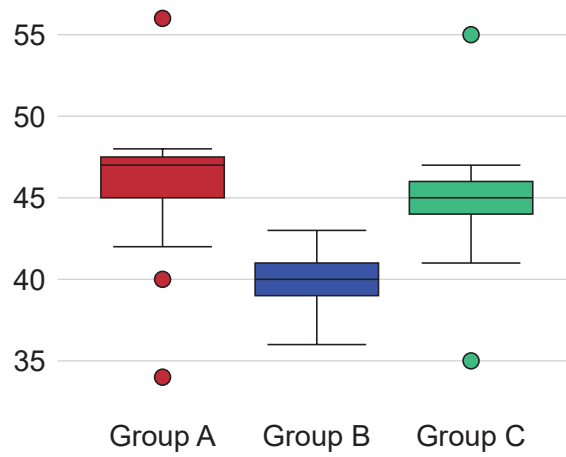
Figure 3.8: Boxplot
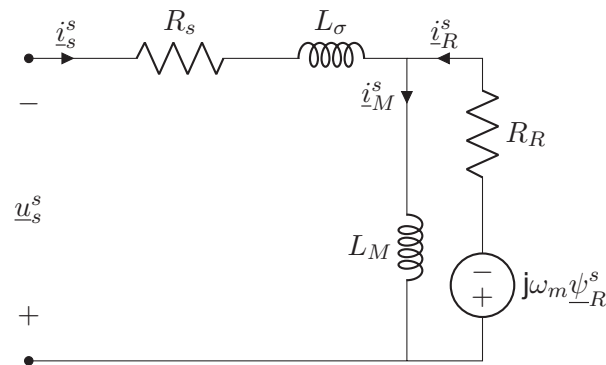
Figure 3.9: The nodes short, V, R and L are presented here, but there a lot more

3.2 Tables and figures

Table 3.1: Wrongly formatted table

	Voltage V	Current A	Power W
Transformer input	234.4	0.50	117.4
Transformer output	25.86	2.72	70.3
Efficiency			60%

Table 3.2: Correctly formatted table

	Voltage V	Current A	Power W
Transformer input	234.4	0.50	117.4
Transformer output	25.86	2.72	70.3
Efficiency			60 %

Table 3.1 and table 3.2 have the same comtents but there are some subtle differences in formatting which makes table 3.2 the superior table of the two. The most obvious change is removing the midrule between the transformer input and output rows. The efficency row is the odd man out and a midrule has been used to emphasise the difference between the transformer rows and the efficiency row. The delimiters in the voltage, current and power columns are aligned. The horizontal lines (rules) fits to the content and instead of protruding. The spacing between 60 and the percentage sign is correctly adjusted.

Figure 3.10: Just a normal figure

(a) A subfigure

(b) A subfigure

Figure 3.11: A figure with two subfigures

(a) A subfigure

(b) A subfigure

(c) A subfigure

(d) A subfigure

Figure 3.12: A figure with four subfigures

Referring to the figure as a whole fig. 3.12 or to an individual sub figure fig. 3.12a is done the normal way with `\cref{}` commands.

3.3 Equations

In-line math is easy. Anything surrounded by dollar signs becomes a math field. Here is an example: $f(x) = 2x - 1$. Also anything inside the "\begin{equation}" and "\end{equation}" environment is also a math field. Examples are shown below.
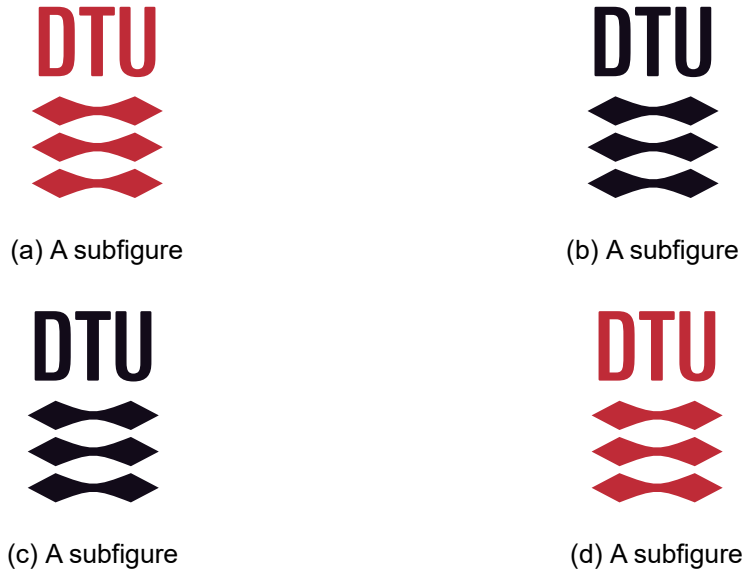
All equations use the default latex font. Some might say it looks weird with a serif font for equations and a sans-serif font for the body text. However, it is very unpractical to change the math font in latex which is the exactly the reason why this has not been done. One benefit of the serif style math font is the clear distinction between symbols (variables) and units.

On the subject of units, those are all taken care of by the `\siunitx` package. Whenever there is a number followed by a unit one should write \SI{number}{unit}. Note this command is case sensitive. If a unit should follow a variable use the command \si{unit} (also case sensitive).

The ideal gas law is shown in eq. (3.1).

$$p \cdot V = n \cdot R \cdot T \tag{3.1}$$

$$\frac{\partial}{\partial t} \int_0^\delta U \, dy = -\delta \frac{1}{\rho} \frac{\partial P}{\partial x} - U_f(t)^2 \tag{3.2}$$

$$d_{step} = \sqrt{\frac{\delta}{\frac{dw}{dp_v}} \cdot t} = \sqrt{\frac{1.0 \times 10^{-11} \, \mathrm{kg/(m\,s\,Pa)}}{\frac{5.4 \, \mathrm{kg/m^3}}{233.82 \, \mathrm{Pa}}} \cdot 7200 \, \mathrm{s}} = 0.001\,766 \, \mathrm{m} = 1.766 \, \mathrm{mm} \tag{3.3}$$

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$$x = \mathrm{x}, \mathbf{x}, \mathit{x}, x_{1_{2_{3_4}}}^{1^{2^{3^4}}} \cdot hello * \text{hello world} \cdot \text{equation without number}$$

Notice how the `aligned` environment can be used to align the equilibrium arrows in eq. (3.4). Only one equation number is generated using this method. Alternatively if you want an equation number for each line see eqs. (3.5) to (3.6).

$$\begin{aligned} CH_3COOH + OH^- &\rightleftharpoons CH_3COO^- + H_2O \\ H_2O &\rightleftharpoons H^+_{(aq)} + OH^-_{(aq)} \end{aligned} \tag{3.4}$$
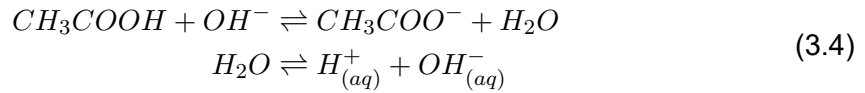
$$f(x) = 1 + x - 3x^2 \tag{3.5}$$

$$g(x) + y = 3x - \frac{1}{2}x^3 \tag{3.6}$$

3.4   Listings (code)

Listing 3.1 is a nicely formatted block of code. A listing will automatically continue on the next page if it encounters a page break. Many different programming languages can be highlighted. Check the `listings` package documentation for a list of supported programming languages.

```
1  %% Monte Carlo simulation, estimation of pi
2  m=1E7;
3
4  x=rand(m,1);
5  y=rand(m,1);
6
7  g = x.^2+y.^2-1;
8
9  %dots outside
10 Pf = sum((g)<=0)/m
11
12 pi = 4*Pf
```

Listing 3.1: Monte Carlo simulation to estimate the value of π

Portable Ultrasound System for Blood Velocity Estimation

Bibliography

[1] Philipp Lehman et al. *Biblatex – Sophisticated Bibliographies in LaTeX*. 2018. URL: `https://www.ctan.org/pkg/biblatex`.

A   Title

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.