LaTeX template for the ELE2038 coursework assignment

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1 Introduction

1.1 Simple commands

You may write inline equations using the dollar sign, e.g., $x = 1 = \alpha$ and $y = x^2 - \sqrt{z}$. An example of a display-style equation is

$$a = b + c. \tag{1.1}$$

Note that the above equation has a label; this is so we can refer to Equation (1.1) in the text. The following equation involves the Laplace transform

$$\mathscr{L}\{e^{at}\} = \frac{1}{s-a}, \tag{1.2}$$

and is defined for all complex numbers $s \in \mathbb{C}$ with $\mathbf{re}(s) > a$. Note how curly brackets are written in the above equation. The inverse Laplace transform is denoted by $\mathscr{L}^{-1}$. LaTeX supports all sorts of mathematical symbols; examples are $\sin(x)$, $\cos(x)$, $\sqrt{x}$, $\ln x$, $\log x$.

If you want to start a new paragraph, leave a black line from the previous paragraph. Do not use a double backslash to leave more space between paragraphs. One detail to which you need to pay attention is that all equations are part of your paragraph: you need to introduce them and punctuate them. For example, Newton's second law of motion states that

$$F = ma, \tag{1.3}$$

where m is the mass, etc. Note that we have not left any blank lines before and after the equation, and there is a comma at the end.

1.2 Very useful tricks

Refer to other sections as Section 1.1. An example of a numbered list

1. first item,
2. second item.

An example of an itemized list is

- first item,
- second item.

In any case, avoid using lists.

Links are like this. We also have **boldface**, *italics*, *emphasised*, `truetype`, SMALL CAPS, and so on.

Generally you should avoid including code in your report, but there are exceptions such as if you are writing a software manual, a tutorial on your software library. If you *must*, here is an example of how you can typeset your code:

```
import numpy as np

# This is a comment
x = np.array([1, 2, 3])
y = np.array([4, 5, 6])
```

1.3 More symbols

We denote the real numbers as $\mathbb{R}$, the natural number by $\mathbb{N}$, and the complex numbers as $\mathbb{C}$. If you want to write a limit, write

$$z = \lim_{s \to 0^+} \frac{s+1}{s^3 + s^2 - 5s + 9}. \tag{1.4}$$

An an example of a limit where the variable tends to infinity is

$$\lim_{s \to \infty} \frac{s+1}{s^3 + s^2 - 5s + 9}. \tag{1.5}$$

Example of an integral

$$\int_0^\infty e^{-s\tau} f(\tau) \mathrm{d}\tau. \tag{1.6}$$

The following three equations are aligned

$$a = 1, \tag{1.7}$$
$$b = 2, \tag{1.8}$$
$$c = 3. \tag{1.9}$$

Note that we use the ampersand symbol to align these equations at the equals sign. Next, here are aligned equations without equation numbers

$$\begin{aligned} a &= 1, \\ b &= 2. \end{aligned}$$

If you have to show mathematical derivations, align your equations as follows

$$\begin{aligned} \frac{1}{2+3j} &= \frac{2-3j}{(2+3j)(2-3j)} \\ &= \frac{2-3j}{2^2+3^2} \\ &= \frac{2-3j}{13} \\ &= \frac{2}{13} - j\frac{3}{13}. \end{aligned} \tag{1.10}$$

You can use the `notag` command to suppress the numbering of equations. Often we have to write multiple equations linked with an "if and only if" ($\Leftrightarrow$) or an "implies" ($\Rightarrow$). Then, we align our equation as follows:

$$\begin{aligned} & as + 4 + 2s = b + (8 + a)s \\ \Leftrightarrow\ & (a + 2)s + 4 = b + (8 + a)s \end{aligned}$$

We may want to use boldface math notation such as $\boldsymbol{x}$, but this should be used sparingly. We can write vectors

$$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}, \tag{1.11}$$

and matrices

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}. \tag{1.12}$$

We can also write that according to Taylor's Theorem,

$$\phi(x) \approx \phi(x_0) + \phi'(x_0)(x - x_0). \tag{1.13}$$

Note that we have used the symbol $\approx$.

Often, you will need to write subscripts, such as x_1, or superscripts, such as x^2, or both, such as x_1^2.

When it comes to differential equations, the first derivative with respect to time can be denoted as $\dot{x}$, or

$$\frac{\mathrm{d}x}{\mathrm{d}t}. \tag{1.14}$$

Note that we have used the symbol d rather than d; d is defined in the preamble (see the file `preamble.tex`).

The second derivative is denoted as $\ddot{x}$, or

$$\frac{\mathrm{d}^2x}{\mathrm{d}t^2}. \tag{1.15}$$

If you want your fraction to be smaller, write

$$\tfrac{\mathrm{d}^2x}{\mathrm{d}t^2}. \tag{1.16}$$

An ODE may look like this

$$\ddot{x} + 0.1\dot{x} + x = u. \tag{1.17}$$

2 Figures

There are two ways to include a figure in your LaTeX document. The easiest thing to do is to upload the figure to Overleaf and put it inside the folder `figures/` (see the left side bar). Then you can include your figure as shown here. You need to include All figures need to be referenced in the text. We can write that Figure 1 illustrates the Hill equation, which is a simple pharmacodynamic model. It is very important to make sure that the axis labels and legend of the figure are legible and all lines are sufficiently thick.

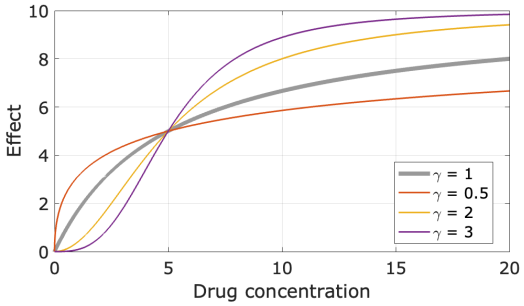

Figure 1: You may of course include figures in your document like this one. The caption should explain what we see in the figure and should be sufficiently informative. Avoid too short captions like "System response".

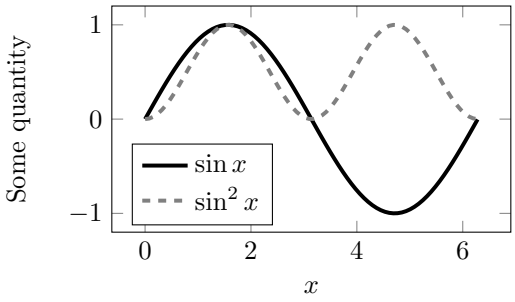

Figure 2: Plot of $f(x) = \sin x$ (solid black line) and $g(x) = \sin^2(x)$ (gray dashed line) using Tikz.

Another way to include figures in your document is by using Tikz. This is more advanced. Tikz will create vectorised graphics and the axis labels and legends will have the same nice font style and size as the rest of your document. An example is shown in Figure 2.

As a rule, LaTeX will not position the figures at the exact position you have put them in your code. It will position them at the optimal position. I would advise you not to worry about the positioning of your figures until after you have completed your report. You can force LaTeX to position your figures at a specific location, but chances are you won't have to do this.

Note also that figures like Figure 1 and 2 are nice and legible. You don't have to include huge figures in your report[1].

[1] Last but not least, this is how to write footnotes.