LaTeX Example
ECS 120

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Non-numbered section

Sections are a good way to break up homework solutions by problem.

1 Numbered section

Or you can use a numbered section.

2 How to do things that are easy in a word processor

Normal text appears mostly as you type it. A notable exception is "quotation marks"; the left ones are wrong if you use the "normal quotes". Whitespace is ignored, but you can introduce more spaces between words if you want. I like to keep sentences on separate lines in the LaTeX code, but this will not introduce a new paragraph.

To start a new paragraph, you need two newlines in the LaTeX code.

You can also force text to
appear on the next line in the same paragraph.

You can make text **bold**, or in *italics*, or underlined. Instead of italics, I prefer to use *emphasis*, because of Theorem 5.4.

You can create numbered lists:

1. first numbered list item
2. By using labels, you can reference the list numbers so they automatically update if you add or delete items.
3. This is a reference to the labeled list item, which is number 2. You may have to compile twice to get the number correct.

You can also create bullet-point lists:

- first bullet list item
- second bullet list item

The `verbatim` environment is good for writing code, not only because it uses a fixed width font, but also because nothing in it is interpreted as a LaTeX command:

```
int x = 5; // \emph{initial} position
double y = x*x;
```

You can also use it `inline`, but often what you really want instead is merely `fixed width font, in which you can still have LaTeX commands such as` *italics*.

Hyperlinks show up in PDF documents compiled from LaTeX: link to course page

You can also just display a URL that is itself a link (for some reason this displays tilde characters better than the previous): https://smartsite.ucdavis.edu/portal/site/fall2015ecs120

3 How to write mathematics

Readable mathematical notation is the main reason to use LaTeX instead of a word processor. There's much more to math in LaTeX than this, but I want to give just the basics that will be most of what is needed for this course.

You can put math in the same line as the text like this: $x = 5$. Or you can put it on its own line like this:

$$x = 5.$$

You can also number equations:

$$x \neq 6. \tag{1}$$

Now we can reference equation (1).

Multiline equations are also useful:

$$\begin{aligned} x &= y + z \\ &\leq 2y \\ &< 3y \qquad \text{if } y > 0 \end{aligned}$$

It's possible to number these also, or number only some of them:

$$\begin{aligned} x &= y + z && (2) \\ &\leq 2y \\ &< 3y && (3) \end{aligned}$$

And we can make a reference to inequality (3).

Here's a list of common useful math symbols:

- x^2. Use curly braces to superscript multiple characters, so you get x^{100} instead of x^100.
- n_2, x_{n^2}, x_n^2, $O(n \log n)$, $\hat{x}$, $\overline{A}$, x_1', x_n''
- Plain text in math mode: $\{p \in \mathbb{N} \mid p \text{ is prime}\}$
- Spaces in math mode: $\{\ p \in \mathbb{N} \mid p \text{ is prime }\}$
- $\frac{\pi^2}{6} = \sum_{n=1}^{\infty} \frac{1}{n^2}$
- $\zeta(z) = \prod_{n=1}^{\infty} \frac{1}{1-p_n^{-z}}$

- $\mathbb{N} = \{0, 1, 2, \ldots\} = \mathbb{Z} \setminus \{-1, -2, \ldots\} \subseteq \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R} \not\subseteq \mathbb{R}^+$
- Greek letters: $\alpha, \beta, \gamma, \Gamma, \delta, \Delta, \epsilon, \zeta, \eta, \theta, \Theta, \kappa, \lambda, \Lambda, \mu, \nu, \xi, \Xi, \pi, \Pi, \rho, \sigma, \tau, \phi, \Phi, \chi, \psi, \Psi, \omega, \Omega$
- complexity classes: $\mathsf{P}, \mathsf{NP}, \mathsf{DTIME}(n^3)$
- Σ^*, $\{0,1\}^*$
- $\delta : Q \times \Sigma \to Q$
- $(\forall X)\ |\mathcal{P}(X)| > |X|$
- $\lim_{n\to\infty} \frac{1}{n} = 0$
- $(\forall n \in \mathbb{N})(\exists m \in X) m > n \iff |X| = \infty \implies |X| \geq |\mathbb{N}|$
- $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$
- $\Sigma^* = \bigcup_{i=0}^{\infty} \Sigma^i$

Note how ugly this looks:

$$(\frac{1}{n^2})$$

Use `\left` and `\right` to make pairs of matching delimiters big enough for the text they contain:

$$\left(\frac{1}{n^2}\right)$$

For defining sets where you want the vertical line in the middle to scale with the text size, it is useful to have a "phantom delimiter" (represented by a period):

$$X = \left\{ \frac{n^2}{2^{n^3}} \middle| n \in \mathbb{N} \right\}$$

Of course this only works if you guess properly whether the left or right is bigger, which failed here:

$$X = \left\{ n \middle| \frac{n^2}{2^{n^3}} \geq \frac{1}{10} \right\}$$

4 Commands

You can define commands that act like macros. These both look the same, but one is easier to type: NP and NP. If LaTeX complains that the command is already defined, redefine it.

And then use it: P

Commands can take arguments. We can make a command for the "make set delimiter big enough for the left-hand text" idea, which takes two arguments whose names are `#1` and `#2`,

and then we can call it with two arguments: $X = \left\{ \frac{n^2}{2^{n^3}} \middle| n \in \mathbb{N} \right\}$

In this document I'm defining commands as we go, but the normal way to do it would be to define them in the preamble (the part before `\begin{document}`).

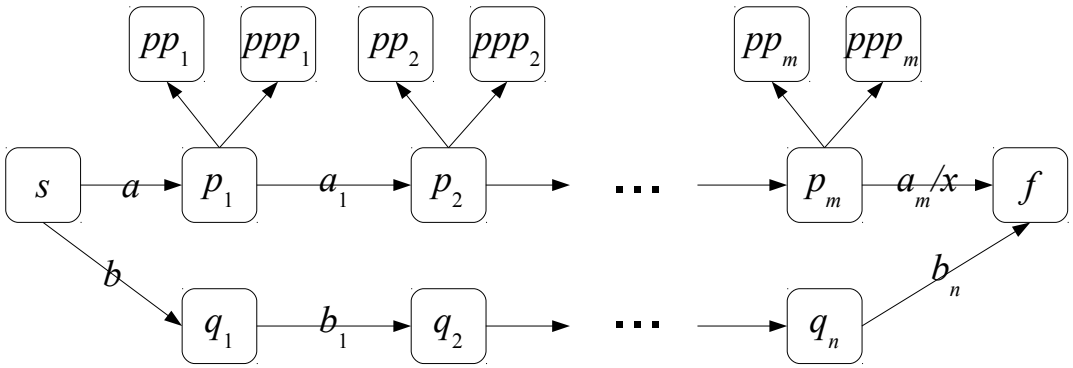

Figure 1: A figure

5 Theorems/Lemmas/Definitions/etc.

Using the package `amsthm` alone does not provide environments for theorem/lemma/definition/etc. You have to define your own using the `\newtheorem` command.

Definition 5.1. *Given $n \in \mathbb{N}$, let $\pi(n) = |\{\ p \in \mathbb{N} \mid p \leq n$ and p is prime $\}|$.*

Theorem 5.2. $\lim_{n\to\infty} \frac{\pi(n)}{n/\ln n} = 1$.

Proof. I don't remember. □

The following is a corollary of Theorem 5.2:

Corollary 5.3. *There are an infinite number of primes.*

Theorem 5.4. *In an environment where the text is already italicized, using the italics command will not change it, but it can still be* emphasized *with the command* `\emph`*.*

6 Figures

To include a figure that is a PDF file or a PNG file, use the `figure` environment. It is famously difficult in LaTeX to get figures to go where you want them to; that's why it's important to label them so you can refer to them, such as Figure 1.