

§1. Introduction

All documents start with the `\documentclass` command. The default class is “Article,” although there many others that can be found on this website: <https://www.ctan.org/topic/class>.

Some other useful document classes that you should know about are “Report,” “Beamer,” and “Book.”

```
» \documentclass{article}
```

This supports the most commonly used font sizes – 10 (default), 11, and 12. If you are in need of a smaller/larger font size, use:

```
» \documentclass{extarticle}
```

The sizes available are 8pt, 9pt, 10pt, 11pt, 12pt, 14pt, 17pt, and 20pt.

You can further add global font commands using:

```
» \documentclass[12pt]{extarticle}
```

Additionally, to add alternate headers and footers to your document, you can add:

```
» \documentclass[12pt, twoside]{extarticle}
```

We will see how this works later on.

Additionally, some other global options that one may consider adding are:

```
» \documentclass[fleqn]{extarticle}
```

This aligns equations to the left instead of centering them.

```
» \documentclass[leqno]{extarticle}
```

This places equation numbers on the left side of the equations instead of the default right.

```
» \documentclass[a4paper]{extarticle}
```

One can also change the default letter dimension to A4, which is common outside the US.

§1.1. The Preamble

The next step is to call all required packages. Our focus for this session will be the default article class, for which the required packages may be different. It also depends on the reason for creating the document in the first place. We will cover some of the most essential for the purpose of writing a paper or solutions to problem sets, typing notes, and making graphs.

Packages are added to the “preamble” of the document - the part after declaring the document class and before the `\begin{document}` command.

The most basic is the geometry package which allows you to set custom margins:

```
» \usepackage[top=1in,bottom=1in,left=1in,right=1in]{geometry}
```

§1.2. Formatting and Layout

Next, we have the formatting and layout packages:

```
» \usepackage{enumitem}
```

Allows you to adjust spacing, label formatting, and overall appearance of lists. For example, if you want your item list to be left aligned, ordered using roman numerals, and bolded, you can use:

```
» \begin{enumerate}[left=0pt, label=\textbf{\roman*.}]
```

The output looks like this:

- i. Item 1
- ii. Item 2

This package is useful for global commands, but you can also change the label within the environment for greater control. For example, you can have the following:

» \item[\$\blacksquare\$]

The output looks like:

- A blacksquare label.

» \usepackage{titlesec}

This package allows you to customize section headings and enables fine-tuning of section, sub-section, and other heading levels, including font size, spacing, and formatting.

» \titleformat{\section}{\normalfont\Large\bfseries}{\S \thesection.}{0.5em}{}

» \titleformat{\section}[block]{\centering\bfseries}{\Roman{section}.}{0.5em}{}

The one below is the format for the ECON 601 lecture notes.

```
» \usepackage{caption}
```

Customizes captions for figures and tables and allows you to adjust the style, format, and placement of captions, including multi-line captions and custom fonts.

```
» \captionsetup[figure]{labelsep=period,labelfont=it, textfont=normal}
```

```
» \captionsetup[table]{labelsep=period,labelfont=bf, font=sc}
```

TABLE 1. CAPTION USING THE SECOND COMMAND

» \usepackage{parskip}

Adjusts paragraph spacing and eliminates paragraph indentation and inserts a small vertical space between paragraphs for a cleaner look.

```
» \usepackage{booktabs}
```

Enhances table formatting and provides better rules (lines) for tables, creating a professional and aesthetically pleasing look, especially for tables in academic writing.

This allows the use of `\toprule`, `\midrule`, `\bottomrule`, and `\addlinespace`. Here's an example:

Look at the line above.	It is thicker than the one below.
Bottom and top rules are thicker than mid rule.	Also note the extra space below.

» `\usepackage{multicol}`

Enables multi-column layouts and allows text to flow into multiple columns, useful for newspaper-style layouts or densely packed documents.

TABLE 2. ADF TEST: REGRESSION RESULTS I

Coeff.	tStat Test 1	pValue	tStat Test 2	pValue	tStat Test 3	pValue
<i>c</i>	-3.5071	0.0005	-7.0899	0.0000	-4.0902	0.0000
<i>d</i>	13.1878	0.0000	23.9935	0.0000	12.2333	0.0000
<i>a</i>	30.9290	0.0000	26.2036	0.0000	31.3311	0.0000

» `\usepackage{multirow}`

Merges multiple rows in a table and allows a cell to span several rows in a table, useful for complex table designs.

TABLE 3. ADF TEST: REGRESSION RESULTS II

Coeff.	tStat Test 1	pValue	tStat Test 2	pValue	tStat Test 3	pValue
Merged	-3.5071	0.0005	-7.0899	0.0000	-4.0902	0.0000
	13.1878	0.0000	23.9935	0.0000	12.2333	0.0000
	30.9290	0.0000	26.2036	0.0000	31.3311	0.0000
	23.9290	0.0000	6.4252	0.0000	1.8519	0.0000

» `\usepackage{xcolor}`

Adds color to text and backgrounds, and supports a wide range of color models and allows precise customization of colors for different elements in your document.

You can define custom colors using this as: » `\definecolor{DukeNavyBlue}{RGB}{1, 33, 105}`
 » `\definecolor{DukeRoyalBlue}{RGB}{0, 83, 155}`

This text appears in the custom font color, Duke Navy Blue.

This text appears in the custom font color, Duke Royal Blue.

You can change the color of individual sentences by using the command: `\textcolor{color}{text}`.

To change the color of a larger block of text, use `\color{color}` and switch it back to the original by using the same command.

» `\usepackage{ulem}`

Underlines text and provides additional text decorations and offers underlining, strikethrough, and double underlining, with control over how these are applied (e.g., color, style). The existing commands are:

» `\uline{important}`: important

» `\uuline{urgent}`: urgent

» `\uwave{boat}`: boat

» `\sout{wrong}`: ~~wrong~~

» `\xout{removed}`: ~~removed~~

» `\dashuline{dashing}`: dashing

» `\dotuline{dotty}`: dotty

The default underline command is `\underline`, which looks like this, while the `\uline` command looks like this.

» `\usepackage{setspace}`

Adjusts line spacing and allows you to change the document's line spacing, supporting single (`\singlespacing`), one-and-a-half (`\onehalfspacing`), and double spacing (`\doublespacing`), among others.

§1.3. Graphing and Figures

The packages above are some of the most basic required for clear formatting and layout. We now move on to graphing and figure packages.

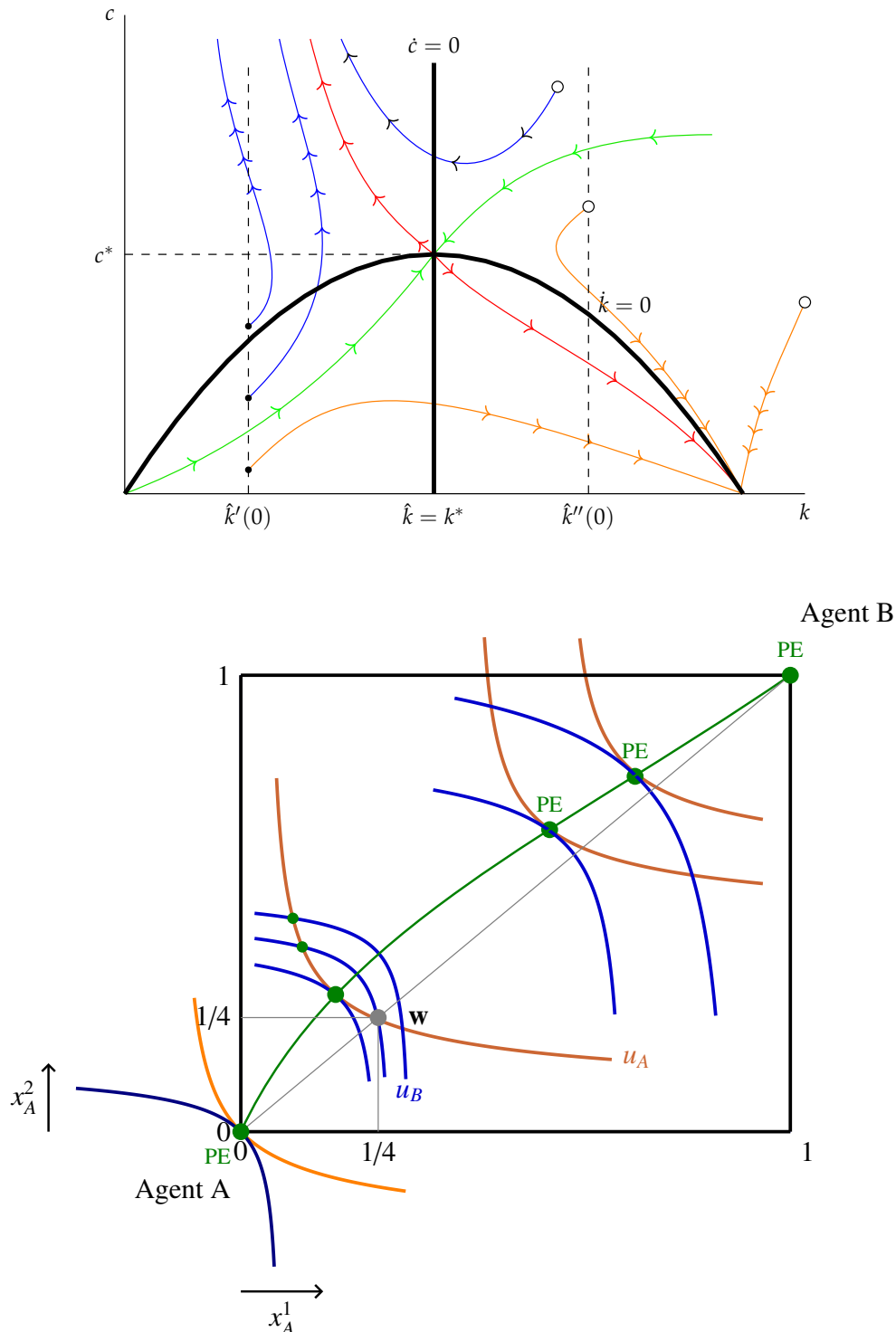
» `\usepackage{graphicx}`

Manages the inclusion of graphics in a document and allows you to easily include images, adjust their size, and position them within your document.

» `\usepackage{tikz}` and `\usepackage{pgfplots}`

The former creates high-quality vector graphics directly in LaTeX and provides a powerful environment for creating complex diagrams, plots, and illustrations. The latter plots high-quality graphs and data visualizations and tikz to create 2D and 3D plots, with extensive customization options for axes, labels, colors, and more.

Some examples of what's possible are:



§1.4. Math Equations and Symbols

Moving on to math packages:

» `\usepackage{amsmath}`

Facilitates advanced mathematical typesetting and introduces various environments for displaying equations, including multiline equations, matrices, and aligned equations, making it easier to format complex mathematical content.

Some commands we will discuss are `\begin{equation}`, `\begin{align}`, `\begin{alignat}`, `\begin{gather}`, `\begin{cases}`, and `\begin{bmatrix}`.

» `\usepackage{mathtools}`

Enhances the functionality of `amsmath` and provides additional tools for mathematical typesetting, such as extending arrows, creating paired delimiters, and more customizable alignment environments.

» `\usepackage{amsthm}`

Creates and customizes theorem-like environments and allows you to define theorems, lemmas, corollaries, proofs, and similar structures with consistent formatting and numbering.

Some examples are:

» `\newtheorem{theorem}{Theorem}[section]`

» `\newtheorem{corollary}{Corollary}[theorem]`

» `\newtheorem{lemma}[theorem]{Lemma}`

» `\newtheorem{axiom}{Axiom}`

These allow you to use predefined environments by using the commands:

» `\begin{theorem}`

» `\begin{corollary}`

» `\usepackage{amsfonts}`

Provides additional mathematical fonts and offers a variety of special fonts, such as blackboard bold and fraktur, often used for specific mathematical notations like sets of numbers or algebraic structures.

» `\mathbb{R}: \mathbb{R}`

» `\mathbb{N}: \mathbb{N}`

» `\mathbb{Z}: \mathbb{Z}`

Will generally be required.

» `\usepackage{mathrsfs}`

Provides a script font for mathematical symbols and allows the use of a calligraphic script font, often used for denoting sets, categories, and other mathematical objects.

» `\mathscr{A}` gives \mathscr{A}

» `\mathcal{A}` gives \mathcal{A} and does not require calling any additional packages

Most of the time, the latter should do the job.

» `\usepackage{amssymb}`

Adds additional mathematical symbols and provides a wide range of symbols, including those for set theory, logic, and more, complementing the standard symbol set provided by LaTeX.

Almost all necessary math symbols are available using this package. Most importantly for our purposes:

» `\implies`: \implies

» `\succsim`: \succsim

» `\qed`: \blacksquare (Can alternatively use `\square` \square or `\blacksquare` \blacksquare)

§1.5. Miscellaneous Packages

Here are some additional useful packages:

» `\usepackage{minted}`

The minted package in LaTeX is used for formatting and highlighting source code within a L^AT_EX document.

Here are a few examples:

» `\begin{minted}[linenos, frame=single, bgcolor=lightgray]{python}`

```
1 def hello_world():
2     print("Hello, world!")
```

» `\begin{minted}[bgcolor=white]{java}`

```
def hello_world():
    print("Hello, world!")
```

This, along with `\usepackage{listings}` will be very helpful for COMPSCI classes.

» `\usepackage{hyperref}`

The package is used to create hyperlinks within a document, enhancing its navigation and interactivity. It can generate clickable links for references, citations, the table of contents, URLs, and more. Additionally, it allows for the customization of link appearance, making it an essential tool for documents that are meant to be viewed digitally, such as PDFs.

You can customize it using the following:

```
\hypersetup{
  colorlinks=true ,
  linkcolor=black ,
  filecolor=cyan ,
  citecolor=red ,
  urlcolor=violet ,
  pdftitle={Introduction to Overleaf},
}
```

» `\usepackage{url}`

Allows you to add a website’s URL as a link in the document. For example, here’s the link to the package documentation: <https://www.ctan.org/pkg/url>.

» `\url{https://www.ctan.org/pkg/url}`.

Some final packages to add are:

» `\usepackage[english]{babel}`

Manages language-specific typographical rules and hyphenation patterns. If you are writing a document in English, loading `babel` with `[english]` ensures that LaTeX uses correct English hyphenation and punctuation rules.

» `\usepackage[T1]{fontenc}`

Specifies the output font encoding, particularly for handling accented characters and special symbols.

Example: If you write “Curaçao” in your document, using T1 encoding will ensure that the character ç is treated correctly, both in terms of appearance and hyphenation.

Finally, you can load additional fonts. Here’s a short list of fonts I sometimes use as an alternative to the Computer Modern default.

```
\usepackage{txfonts}
\usepackage{times}
\usepackage{mathptmx}
\usepackage{kpfonts}
\usepackage{iwona}
\usepackage{cmbright}
\usepackage{ebgaramond}
\usepackage[garamondx]{newtxmath}
\usepackage{garamondlibre}
\usepackage[garamond]{newtxmath}
\usepackage{mathpazo} % palatino linotype
```



```

» \usepackage{fancyhdr}

\usepackage{fancyhdr}
\pagestyle{fancy}
\fancyhf{}
\fancyfoot[C]{\thepage}
\fancyhead[RE]{\textit{\nouppercase{\rightmark}}} % for the subsection
\fancyhead[LO]{\textit{\nouppercase{\leftmark}}} % for the section
\fancyhead[RO]{Consumer Surplus}
\fancyhead[LE]{ECON 601: Microeconomic Theory}
\fancyhead[CO]{\textbf{Lecture 6}}

\renewcommand{\subsectionmark}[1]{\markright{\thesubsection.\ #1}}
\renewcommand{\sectionmark}[1]{\markboth{\thesection.\ #1}}

```

§2. Commands and Functions

The most basic math environment is enclosing between \$ signs. For example:

» One of the most basic math identities is: $(a + b)^2 = a^2 + 2ab + b^2$.

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If you want the equations to appear on a separate line, you can enclose them within two dollar symbols. For example:

» One of the most basic math identities is:

$$(a + b)^2 = a^2 + 2ab + b^2.$$

» One of the most basic math identities is: $(a+b)^2 = a^2 + 2ab + b^2$.

Often times, you will need to reference your equations throughout the document. In those instances, it is better to use the `\begin{equation}` or `\begin{align}` environments.

Consider the following equation:

$$U_0 = \int_0^{\infty} e^{-(\rho-\lambda)t} \cdot u(t) dt, \quad (2.1)$$

and notice how the numbering is based on the section. That is, it is the first equation in the second section of the document. You can do this by placing the command

```
\numberwithin{equation}{section}
```

in the preamble.

You can also label your equations:

```
\begin{equation}\label{eq:Some-Equation-For-Reference-Later}
```

for reference later. For example:

- » The lifetime utility function is given by equation (2.1).
- » The lifetime ... equation `\eqref{eq:Lifetime-Utility}`.

You can also use `\ref{}` to reference objects you have labelled but they do not have a parentheses around them and by placing an asterisk after “equation,” you can remove the numbering: `\begin{equation*}`.

- » Example: `\boxed{"equation here"}`

$$\frac{\dot{c}}{\dot{k}} = \frac{c \cdot [f'(k) - \delta - \rho] / \sigma}{f(k) - (\lambda + \delta)k - c}.$$

Similar to the `\begin{equation}` environment, the other important command is `\begin{align}`, which allows us to write multiple equations and align them.

$$\begin{aligned} \frac{\frac{\beta}{\chi} \left(\frac{w-\chi}{\chi} \right)^{\beta-1} \cdot w}{\left(\frac{w-\chi}{\chi} \right)^{\beta}} &= 1 \\ \Rightarrow \frac{\beta w}{\chi} &= \frac{w-\chi}{\chi} & (2.2) \\ \Rightarrow w &= \frac{\chi}{1-\beta} = \frac{(1-bu)w_a}{1-\beta}. \end{aligned}$$

There’s one thing worth noting above. Even though the equations are within the `\begin{align}` environment, only the middle equation is numbered. To do this, you can place `\nonumber` after the end of the equation.

Additionally, each equation is separated from the next by using double backslashes – `\\`.