Latex Certificate Course Instructions

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1 amsmath Package

The `amsmath` package is used for mathematics commands and environments for writing equations, matrices, ... The current version of this package is 2.17i and is maintained by LaTeX3 Team. The documentation is available at CTAN.

The `amsmath` package from American Mathematical Society have environments for writing equations, and matrices. It also provides commands for different types of dots, arrows, fractions, and congruences. There are commands for delimiters and operators of different sizes. Also it provides mechanisms for multiline superscripts/subscripts and a completely new class of operators. And it provides boldface mathematics and italic greek letters.

1.1 Writing Fractions

The `amsmath` package provides the `\frac` command for writing fractions. This command take two arguments where first argument in the numerator and second the denominator of the fraction. For example, `$\frac{1}{2}$` gives $\frac{1}{2}$.

1.2 Commands with Multiple Arguments

Usually, LaTeX commands have one or two arguments and many optional arguments. Thus, LaTeX uses a pair of braces { } for each argument of a command. If there is a command `\many` which takes 4 arguments, then the command will looks like `\many{...}{...}{...}{...}`. However, it uses only a pair of brackets [ ] for optional arguments. Instead of using multiple brackets, LaTeX gives different names to optional arguments as we have seen in the case of `geometry` package which has many optional arguments. `top, bottom, left` and `right` are only a few among them.

1.3 A few more Commands

The amsmath package also provides the following commands,

sqrt to write surds.
For example, `$\sqrt[3]{x}$` gives $\sqrt[3]{x}$.

binom to write binomial coefficients.

For example, $\binom{n}{r}$ gives $\binom{n}{r}$.

2 Writing equations

The `amsmath` package has `equation` environment for writing equations.

```
\usepackage{amsmath}
...
\begin{document}
...
\begin{equation}
e^{i\pi} + 1 = 0
\end{equation}
...
```

$$e^{i\pi} + 1 = 0 \tag{1}$$

Figure 1: Writing equations

The `equation` environment not only prints the equation in a separate line, but also prints the equation number. This number is automatically updated by LaTeX. If you want to print an equation, but don't want to give any number to it. Then you should use `equation*` environment.

Warning: When you are using `equation` environment, it will automatically switch into math mode. Thus, you should not use math mode explicitly. For example, $\begin{equation}x = 1\end{equation}$ won't work.

Also whenever you switch between `equation` and `equation*` or `itemize` and `enumerate`. You should change both `\begin` and `\end` commands. First you should update both the environment delimiters, and then think about its contents.

2.1 Display Math Mode

The delimiters for display math mode are \[and \]. The mathematical expression written in display math mode is printed on a separate line.

For example, \[\sum_{i = 0}^n 2^n = 2^{n+1} - 1 ^] prints,

$$\sum_{i=0}^{n} 2^n = 2^{n+1} - 1$$

Display math mode is quite useful if the equation doesn't require any numbering or specific alignment.

2.2 Adding text into equations

LaTeX has a different mechanism for adding text inside math mode. This mechanism is useful in adding text into equations written using `equation`.

```
\begin{equation}
f \circ g(\bar{x}) = f(y)
\text{ where }
g(\bar{x}) = y
\end{equation}
```

$$f \circ g(\bar{x}) = f(y) \text{ where } g(\bar{x}) = y \quad (2)$$

Figure 2: Adding text in Equations

2.2.1 Adding spaces in equations

The \ command is used to adding a blank space in math mode. There is a blank space following the \ symbol. For example, (12)(34) and (1 2)(3 4) looks slightly different. You will have to write $(1\ 2)(3\ 4)$ to obtain the latter.

If you want to add more spaces, there are a few commands `\,`, `\:`, `\;`, `\quad`, and `\qquad`. Also sometimes you might feel that that the spacing is too much for your purpose. LaTeX has `\!` command for negative spacing in your expressions.

```
\begin{equation}
a_n = \int_0^{2\pi}\!\!\!
f(x)\overline{\phi_n(x)}\ dx
\end{equation}
```

$$a_n = \int_0^{2\pi} f(x)\overline{\phi_n(x)}\ dx \quad (3)$$

Figure 3: Adding spaces into equations

In figure 3, three negative spaces are added on line 2 before `f(x)` to reduce the space from integral sign. And on line 3, a space is added to separate `dx` from the integrand.

2.3 Writing Matrices

The `amsmath` package has the `\matrix` environment for writing matrices. The LaTeX mechanism for matrices is different. It uses & to separate values in different columns and \\ to separate values in different rows.

Warning : There is a different environment for writing tabular data which supports an additional mechanism to add lines to separate columns and rows. Even if you don't need lines, you shouldn't write tabular data using the `matrix` environment.

2.4 Matrices with different delimiters

The `amsmath` package supports different delimiters for matrices. The environments `pmatrix`, `bmatrix`, `Bmatrix`, `vmatrix` and `Vmatrix` adds ( ), [ ], { }, | | and ‖ ‖ respectively. For example, $\begin{vmatrix} ... \end{vmatrix}$ may be used for writing determinants.

```
Suppose,
\begin{equation}
\begin{bmatrix}
a_{11} & a_{12} \\
a_{21} & a_{22}
\end{bmatrix}
\begin{bmatrix}
x_1 \\ x_2
\end{bmatrix}
= \begin{bmatrix}
\frac{a_{11}}{a_{22}} &
-\frac{\sqrt[3]{a_{12}}}{a_{21}}
\end{bmatrix}
\end{equation}
```

Suppose,

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} \frac{a_{11}}{a_{22}} & -\frac{\sqrt[3]{a_{12}}}{a_{21}} \end{bmatrix} \quad (4)$$

Figure 4: Equations involving matrices