

College of the Holy Cross, Fall 2019
Math 243 (Professor Hwang)
Problem Set 0, Due Friday, September 6

In Math 243 we'll be using the mathematical typesetting software \LaTeX . Clicking the link for that week's assignment opens the assignment in Overleaf.

When using \LaTeX , instead of worrying about how your writing *looks* on the page (the "presentation") you focus on *meaning* (the "semantics").

Typographical effects are achieved through *semantic macros* such as `\emph`. A *macro* (or *command*) is a case-sensitive string starting with a backslash, and accepting zero or more *arguments*, each enclosed in curly braces. A macro is *semantic* if it specifies what a piece of text **means** (e.g., is emphasized), not how the text **appears** (e.g., is italicized).

Most mathematics is typeset with special macros, as we'll see. Mathematics must occur in *math mode*, i.e., must be surrounded by dollar signs for in-line math, or by `[\]` pairs for displayed math.

1. This item is automatically numbered. What does that tell you about `\item`?

Answer It tells me that `\item` will automatically number the item in numerical order.

2. The double angle formula for the cosine function reads $\cos(2\theta) = \cos^2 \theta - \sin^2 \theta$.

(a) Typeset the double angle formula for sine. (Look up this identity if you've forgotten it.)

Answer $\sin(2\theta) = 2\sin(\theta)\cos(\theta)$

(b) Note that `\theta` gives the Greek letter θ . Typeset at least six other letters from the lowercase Greek alphabet. (Be sure your macros are in math mode!)

Answer $\phi\delta\gamma\psi\beta\alpha$

(c) Do you have a guess about how to get capital Greek letters? (Hint: `\Alpha` would be logical; as it happens, however, a capital alpha is a Roman capital A , so there is no separate macro.) Typeset at least four uppercase Greek letters that have no Roman equivalent.

Answer $\Gamma\Delta\Sigma\Phi$

3. If $y = \phi(x)$, and if we write $y + \Delta y = \phi(x + \Delta x)$, then

$$\frac{\Delta y}{\Delta x} = \frac{\phi(x + \Delta x) - \phi(x)}{\Delta x}, \quad \frac{dy}{dx} = \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x}.$$

Modify parts of this code and see what happens. Things to watch for: What happens if you forget the backslash on a macro name? What happens if you typeset the line above using dollar signs (inline math mode) instead of display math? What happens if you add or remove space characters inside math mode?

Answer If you do not include the backlash on a macro name, the Greek letter is spelled out in English instead of being written as a Greek symbol. If you use dollar signs instead of display math, it deletes the previously existing break in the text allotted to the equation. It appears as though nothing changes when you add or remove characters inside math mode.

4. If a , b , and c are non-zero numbers, and if $ax^2 + bx + c = 0$, typeset the (quadratic) formula for x in terms of a , b , and c .

Hint: The macro `\pm` gives a plus-or-minus sign.¹

Answer

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

5. One fundamental theorem of calculus asserts that if f is a continuous function on a closed, bounded interval $[a, b]$, then

$$\frac{d}{dx} \int_a^x f(t) dt = f(x) \quad \text{for all } x \text{ with } a \leq x \leq b.$$

(a) Modify parts of this code and see what happens. Hints: `\,` gives a thin space, `\quad` gives one em of space, the width of the letter m in the current font, `\quad\quad` gives two ems. The underscore and caret each accept one argument, and make a subscript or superscript. The `\text` command sets its argument in “paragraph mode”. Why is it needed here?

Answer Without `\text`, the words “for all x with...” all become one word and the computer reads it as part of the math equation instead of as English. It also allows for the break in the text. (b) Evaluate the following derivatives and typeset the answers:

$$\frac{d}{dx} \int_0^x e^{\sin t} dt; \quad \frac{d}{du} \int_{\pi}^u \log(1 + e^{t^2}) dt; \quad \frac{d}{dt} \int_{-1}^t \frac{\sqrt{\tan s}}{1 + s^2} ds.$$

Answer

$$e^{\sin x} \quad \log(1 + e^{u^2}) \quad \frac{\sqrt{\tan t}}{1 + t^2}$$

(c) Typeset the other fundamental theorem of calculus, sometimes known as the *evaluation theorem*. Don’t forget to state appropriate hypotheses.

Answer If f is continuous at every point of $[a, b]$, and if F is any anti derivative of f on $[a, b]$, then

$$\int_a^b f(x) dx = F(b) - F(a)$$

¹The tilde character is a *tie* or *non-breaking space*. Using ties is a little fussy, but helps distinguish professional typography. Use a tie where a line break would interrupt the reader’s attention.