

STA 322 - Assignment

L^AT_EX Document

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A L^AT_EX document to showcase scientific writing and use of mathematical symbols.



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Introduction

For this assignment, I worked on different mathematical formulas in L^AT_EX. I was guided by Jason Gross' L^AT_EX exercises [latex].

1 Latex Exercise

1.1 Easy

Please type me! The quick brown fox jumps over the lazy dog (1)

$$e^{i\pi} + 1 = 0 \quad (2)$$

$$e^{i\theta} = \cos \theta + i \sin \theta \quad (3)$$

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \quad (4)$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (5)$$

$$\vec{L} = \vec{r} \times \vec{p} \quad (6)$$

$$\sqrt[3]{2} \quad (7)$$

$$(x+y)^n = \sum_{r=0}^n \binom{n}{r} x^r y^{n-r} \quad (8)$$

$$\sqrt{\frac{a_1^2 + \dots + a_n^2}{n}} \geq \frac{a_1 + \dots + a_n}{n} \geq \sqrt[n]{a_1 \dots a_n} \geq \frac{n}{\frac{1}{a_1} + \dots + \frac{1}{a_n}} \quad (9)$$

$$|\langle x, y \rangle|^2 \leq \langle x, x \rangle \cdot \langle y, y \rangle \quad (10)$$

$$\mathbf{A1:} \varphi \longrightarrow (\psi \rightarrow \varphi)$$

$$\mathbf{A2:} (\varphi \rightarrow (\psi \rightarrow \theta)) \longrightarrow ((\psi \rightarrow \varphi) \rightarrow (\phi \rightarrow \theta)) \quad (11)$$

$$\mathbf{A3:} (\neg \varphi \rightarrow \neg \psi) \longrightarrow (\psi \rightarrow \varphi)$$

1.2 Medium

$$1_A = \begin{cases} 1 & \text{if } x \in A \\ 0 & \text{if } x \notin A \end{cases} \quad (12)$$

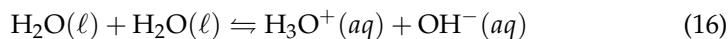
$$\underbrace{n \uparrow \dots \uparrow}_n n = n \rightarrow n \rightarrow n \quad (13)$$

In the following, note the spacing between the = and the ¹1, ²2, and ³3

$$\begin{aligned} 1 \uparrow 1 &= {}^1 1 = 1 \\ 2 \uparrow \uparrow 2 &= {}^2 2 = 4 \end{aligned} \quad (14)$$

$$3 \uparrow \uparrow \uparrow 3 = {}^3 3 3 = 3 \uparrow \uparrow 3 \uparrow \uparrow 3 = \underbrace{3^{3^{3^{3^{3^{\dots^3}}}}}}_{3^{3^3} \text{ threes}}$$

$$\frac{d}{dx} = \lim_{\Delta x \rightarrow 0} \frac{f(x + \Delta x) - f(x)}{\Delta x} \quad (15)$$



$$\Gamma(n+1) \stackrel{\text{def}}{=} \int_0^\infty e^{-t} t^n dt \quad (17)$$

$$\gcd(n, m \bmod n); \quad x \equiv y \pmod{b}; \quad x \equiv y \pmod{c}; \quad x \equiv y \pmod{d} \quad (18)$$

In the following, note the bold symbols.

$$\begin{aligned} \nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon_0} \\ \nabla \cdot \mathbf{B} &= 0 \\ \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\ \nabla \times \mathbf{B} &= \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{B}}{\partial t} \end{aligned} \quad (19)$$

For the following exercise, you will need to use `\usepackage {esint}` to get the symbol \oint .

$$\begin{aligned} \oint_{\partial V} \mathbf{E} \cdot d\mathbf{A} &= \frac{\mathcal{Q}(V)}{\epsilon_0} \\ \oint_{\partial V} \mathbf{B} \cdot \mathbf{A} &= 0 \\ \oint_{\partial S} \mathbf{E} \cdot d\mathbf{l} &= -\frac{\partial \Phi_{B,S}}{\partial t} \\ \oint_{\partial S} \mathbf{B} \cdot d\mathbf{l} &= \mu_0 \mathbf{I}_S + \mu_0 \epsilon_0 \frac{\partial \Phi_{B,S}}{\partial t} \end{aligned} \quad (20)$$

You might find the environment `bmatrix` and `pmatrix` useful for the following exercises.

$$\rho_\theta = \begin{pmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{pmatrix} = \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix} \quad (21)$$

$$\left[\begin{array}{c|ccc} 1 & 0 & \cdots & 0 \\ \hline 0 & * & \cdots & * \\ \vdots & \vdots & \ddots & \vdots \\ 0 & * & \cdots & * \end{array} \right] = \left[\begin{array}{c|ccc} 1 & 0 & \cdots & 0 \\ \hline 0 & * & \cdots & * \\ \vdots & \vdots & \ddots & \vdots \\ 0 & * & \cdots & * \end{array} \right] \quad (22)$$

Note the locations of the bounds on the summation in the following exercise.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N p_i (x_i - \bar{x})^2} = \sqrt{\frac{\sum_{i=1}^N p_i (x_i - \bar{x})^2}{N}} \quad (23)$$

$$\varphi(n) = n \cdot \prod_{\substack{p|n \\ p \text{ prime}}} \left(1 - \frac{1}{p}\right) \quad (24)$$

If you `\usepackage {mathtools}`, you can make it look like

$$\varphi(n) = n \cdot \prod_{\substack{p|n \\ p \text{ prime}}} \left(1 - \frac{1}{p}\right) \quad (25)$$

$${}_{12}^4\mathbf{C}^{5+}_2 \quad {}_{12}^{14}\mathbf{C}^{5+}_2 \quad {}_{12}^4\mathbf{C}^{5+}_2 \quad {}^{14}\mathbf{C}^{5+}_2 \quad {}_{12}\mathbf{C}^{5+}_2 \quad (26)$$

In the following, note the size of $/$, and the spacing on the sizes of the \mid .

$$\mathbb{Q} \cong \left\{ \frac{a}{b} \mid a, b \in \mathbb{Z} \text{ and } b \neq 0 \right\} / \sim \quad (27)$$

$$\frac{a}{b} \sim \frac{c}{d} \iff ad - bc = 0$$

Notice both the horizontal and vertical spacing in the following exercise.

$$\begin{aligned} 1 \uparrow 1 &= {}^1 1 = 1 \\ 2 \uparrow \uparrow 2 &= {}^2 2 = 4 \\ 3 \uparrow \uparrow \uparrow 3 &= {}^3 3 = 3 \uparrow \uparrow 3 \uparrow \uparrow 3 = \underbrace{3^{3^{3^{3^{3^{\dots^3}}}}}}_{3^{3^3} \text{ threes}} \end{aligned} \quad (28)$$

1.3 Insane

Write a command `outputcode` which outputs the code of the document being typeset.

Primes (1 - 10): 2, 3, 5, 7

Primes (1 - 20): 2, 3, 5, 7, 11, 13, 17, 19

Primes (50 - 100): 53, 59, 61, 67, 71, 73

1.4 Diabolical

The Ackermann function is defined as `[latex]`

$$A(m, n) = \begin{cases} n + 1 & \text{if } m = 0 \\ A(m - 1, 1) & \text{if } m > 0 \text{ and } n = 0 \\ A(m - 1, A(m, n - 1)) & \text{if } m > 0 \text{ and } n > 0 \end{cases}$$

Only outputs the result.

`ackermann(2, 2) = 7`

`ackermann(1, 2) = 4`

References