STA 322 - Assignment

LaTeX Document

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A LaTeX document to showcase scientific writing and use of mathematical symbols.

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1 Latex Exercise

1.1 Easy

$$\text{Please type me! The quick brown fox jumps over the lazy dog} \tag{1}$$

$$e^{i\pi} + 1 = 0 \tag{2}$$

$$e^{i\theta} = \cos\theta + i\sin\theta \tag{3}$$

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

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

$$\vec{L} = \vec{r} \times \vec{p} \tag{6}$$

$$\sqrt[3]{2} \tag{7}$$

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

$$\sqrt{\frac{a_1^2 + \cdots + a_n^2}{n}} \geq \frac{a_1 + \cdots + a_n}{n} \geq \sqrt[n]{a_1 \ldots a_n} \geq \frac{n}{\frac{1}{a_1} + \cdots + \frac{1}{a_n}} \tag{9}$$

$$|\langle x, y \rangle|^2 \leq \langle x, x \rangle \cdot \langle y, y \rangle \tag{10}$$

$$\begin{aligned}
&\textbf{A1: } \varphi \longrightarrow (\psi \to \varphi) \\
&\textbf{A2: } (\varphi \to (\psi \to \theta)) \longrightarrow ((\psi \to \varphi) \to (\phi \to \theta)) \\
&\textbf{A3: } (\neg\varphi \to \neg\psi) \longrightarrow (\psi \to \varphi)
\end{aligned} \tag{11}$$

1.2 Medium

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

$$n \underbrace{\uparrow \ldots \uparrow}_{n} n = n \to n \to n \tag{13}$$

In the following, not the spacing between the $=$ and the $^1 1$, $^2 2$, and $^3 3$

$$1 \uparrow 1 = {}^1 1 = 1$$

$$2 \uparrow\uparrow 2 = {}^2 2 = 4$$

$$\tag{14}$$

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

$$\frac{\mathrm{d}}{\mathrm{d}x} = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x} \tag{15}$$

$$\mathrm{H_2O}(\ell) + \mathrm{H_2O}(\ell) \rightleftharpoons \mathrm{H_3O^+}(aq) + \mathrm{OH^-}(aq) \tag{16}$$

$$\Gamma(n+1) \overset{def}{=} \int_0^\infty e^{-t} t^n \mathrm{d}t \tag{17}$$

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

In the following, note the bold symbols.

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\tag{19}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \varepsilon_0 \frac{\partial \mathbf{B}}{\partial t}$$

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

$$\oiint_{\partial V} \mathbf{E} \cdot \mathrm{d}\mathbf{A} = \frac{Q(V)}{\varepsilon_0}$$

$$\oiint_{\partial V} \mathbf{B} \cdot \mathbf{A} = 0$$

$$\tag{20}$$

$$\oint_{\partial S} \mathbf{E} \cdot \mathrm{d}\mathbf{l} = -\frac{\partial \Phi_{B,S}}{\partial t}$$

$$\oint_{\partial S} \mathbf{B} \cdot \mathrm{d}\mathbf{l} = \mu_0 \mathbf{I}_S + \mu_0 \varepsilon_0 \frac{\partial \Phi_{B,S}}{\partial t}$$

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

$$\rho\theta = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \tag{21}$$

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

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

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

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

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

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

$$\mathbf{{}^{4}_{12}C^{5+}_{2}} \quad \mathbf{{}^{14}_{2}C^{5+}_{2}} \quad \mathbf{{}^{4}_{12}C^{5+}_{2}} \quad \mathbf{{}^{14}C^{5+}_{2}} \quad \mathbf{{}_{12}C^{5+}_{2}} \tag{26}$$

In the following, note the size of /, and the spacing on the sizes of the |.

$$\mathbb{Q} \cong \left\{\frac{a}{b} \,\middle|\, a, b \in \mathbb{Z} \text{ and } b \neq 0\right\} \Big/ \sim \tag{27}$$

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

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

$$1 \uparrow 1 = {}^{1}1 = 1$$
$$2 \uparrow\uparrow 2 = {}^{2}2 = 4$$
$$3 \uparrow\uparrow\uparrow 3 = {}^{3}{}^{3}3 = 3 \uparrow\uparrow 3 \uparrow\uparrow 3 = \underbrace{3^{3^{3^{3^{3^{3^{\cdot^{\cdot^{\cdot^{3}}}}}}}}}}_{3^{33} \text{ threes}} \tag{28}$$

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