1 Delimiters

See how the delimiters are of reasonable size in these examples

\[(a + b) \left[ 1 - \frac{b}{a + b} \right] = a,\]
$\sqrt{|xy|} \leq \left| \frac{x + y}{2} \right|$, even when there is no matching delimiter

$$\int_a^b u \frac{d^2v}{dx^2} \, dx = u \frac{dv}{dx} \bigg|_a^b - \int_a^b \frac{du}{dx} \, dv \, dx.$$ 

### 2 Spacing

Differentials often need a bit of help with their spacing as in

$$\int \int xy^2 \, dx \, dy = \frac{1}{6} x^2 y^3,$$

whereas vector problems often lead to statements such as

$$u = \frac{-y}{x^2 + y^2}, \quad v = \frac{x}{x^2 + y^2}, \quad \text{and} \quad w = 0.$$ 

Occasionally one gets horrible line breaks when using a list in mathematics such as listing the first twelve primes 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37.

In such cases, perhaps include \textbackslash mathcode\textbackslash,="213B inside the in-line maths environment so that the list breaks: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37. Be discerning about when to do this as the spacing is different.

### 3 Arrays

Arrays of mathematics are typeset using one of the matrix environments as in

$$\begin{bmatrix} 1 & x & 0 \\ 0 & 1 & -1 \end{bmatrix} \begin{bmatrix} 1 \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} 1 + xy \\ y - 1 \end{bmatrix}.$$
Case statements use cases:

\[ |x| = \begin{cases} 
  x, & \text{if } x \geq 0, \\
  -x, & \text{if } x < 0. 
\end{cases} \]

Many arrays have lots of dots all over the place as in

\[
\begin{pmatrix}
  -2 & 1 & 0 & 0 & \cdots & 0 \\
  1 & -2 & 1 & 0 & \cdots & 0 \\
  0 & 1 & -2 & 1 & \cdots & 0 \\
  0 & 0 & 1 & -2 & \cdots & 1 \\
  \vdots & \vdots & \vdots & \vdots & \ddots & \ddots \\
  0 & 0 & 0 & \cdots & 1 & -2
\end{pmatrix}
\]

4 Equation arrays

In the flow of a fluid film we may report

\[ u_\alpha = \epsilon^2 \kappa_{xxx} \left( y - \frac{1}{2} y^2 \right), \quad (1) \]
\[ v = \epsilon^3 \kappa_{xxx} y, \quad (2) \]
\[ p = \epsilon \kappa_{xx}. \quad (3) \]

Alternatively, the curl of a vector field \((u, v, w)\) may be written with only one equation number:

\[ \omega_1 = \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}, \]
\[ \omega_2 = \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}, \]
\[ \omega_3 = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}. \quad (4) \]
Whereas a derivation may look like
\[(p \land q) \lor (p \land \lnot q) = p \land (q \lor \lnot q) \] by distributive law
\[= p \land T \] by excluded middle
\[= p \] by identity

5 Functions

Observe that trigonometric and other elementary functions are typeset properly, even to the extent of providing a thin space if followed by a single letter argument:

\[\exp(i\theta) = \cos \theta + i \sin \theta, \quad \sinh(\log x) = \frac{1}{2} \left(x - \frac{1}{x}\right).\]

With sub- and super-scripts placed properly on more complicated functions,

\[\lim_{q \to \infty} \|f(x)\|_q = \max_x |f(x)|,\]

and large operators, such as integrals and

\[e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \quad \text{where} \quad n! = \prod_{i=1}^{n} i,
\]

\[\overline{U_\alpha} = \bigcap_\alpha U_\alpha.\]

In inline mathematics the scripts are correctly placed to the side in order to conserve vertical space, as in 1/(1 − x) = \(\sum_{n=0}^{\infty} x^n\).

6 Accents

Mathematical accents are performed by a short command with one argument, such as

\[\tilde{f}(\omega) = \frac{1}{2\pi} \int_{-\infty}^{\infty} f(x) e^{-i\omega x} \, dx,\]
or
\[ \dot{\omega} = \vec{r} \times \vec{I}. \]

## 7 Command definition

The Airy function, \( \text{Ai}(x) \), may be incorrectly defined as this integral
\[ \text{Ai}(x) = \int \exp(s^3 + ix) \, ds. \]

This vector identity serves nicely to illustrate two of the new commands:
\[ \nabla \times \vec{q} = i \left( \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} \right) + j \left( \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x} \right) + k \left( \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right). \]

Recall that typesetting multi-line mathematics is an art normally too hard for computer recipes. Nonetheless, if you need to be automatically flexible about multi-line mathematics, and you do not mind some rough typesetting, then perhaps invoke \texttt{\parbox} to help as follows:
\[
\begin{align*}
&u_1 = -2\gamma e^2 s_2 + \mu e^3 \left( \frac{3}{8} s_2 + \frac{1}{8} s_1 i \right) + e^3 \left( -\frac{81}{32} s_4 s_2^2 - \frac{27}{16} s_4 s_2 s_1 i + \frac{9}{32} s_4 s_1^2 + \frac{27}{32} s_3 s_2^2 i - \frac{9}{16} s_3 s_2 s_1 - \frac{3}{32} s_3 s_1^2 i \right) + \\
&\int_a^b 1 - 2x + 3x^2 - 4x^3 \, dx
\end{align*}
\]
Also, sometimes use \texttt{\parbox} to typeset multiline entries in tables.

## 8 Theorems et al.

**Definition 1 (right-angled triangles)** A right-angled triangle is a triangle whose sides of length \( a, b \) and \( c \), in some permutation of order, satisfies \( a^2 + b^2 = c^2 \).
Lemma 2 The triangle with sides of length 3, 4 and 5 is right-angled.

This lemma follows from the Definition 1 as $3^2 + 4^2 = 9 + 16 = 25 = 5^2$.

Theorem 3 (Pythagorean triplets) Triangles with sides of length $a = p^2 - q^2$, $b = 2pq$ and $c = p^2 + q^2$ are right-angled triangles.

Prove this Theorem by the algebra $a^2 + b^2 = (p^2 - q^2)^2 + (2pq)^2 = p^4 - 2p^2q^2 + q^4 + 4p^2q^2 = p^4 + 2p^2q^2 + q^4 = (p^2 + q^2)^2 = c^2$. 