The cases package*

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This provides a L\LaTeX{} environment \texttt{numcases} to produce multi-case equations with a separate equation number for each case. There is also \texttt{subnumcases} which numbers each case with the overall equation number plus a letter [8a, 8b, etc.]. The syntax is

\begin{numcases}{left_side}
  case_1 & explanation_1 \\ 
  case_2 & explanation_2 \\ 
  ... \\
  case_n & explanation_n
\end{numcases}

Each \texttt{case} is a math formula, and each \texttt{explanation} is a piece of lr mode text (which may contain math mode in \texttt{(...)} or \texttt{$...$}). The explanations are optional. Equation numbers are inserted automatically, just as for the \texttt{eqnarray} environment. In particular, the \texttt{nonumber} command suppresses an equation number and the \texttt{label} command allows reference to a particular case. In a \texttt{subnumcases} environment, a \texttt{label} in the \texttt{left_side} of the equation gives the overall equation number, without any letter.

To use this package, include \texttt{\usepackage{cases}} after \texttt{\documentclass}. You may also specify \texttt{\usepackage[subnum]{cases}} to force all \texttt{numcases} environments to be treated as \texttt{subnumcases}.

∗ This manual corresponds to \texttt{cases v2.5}, dated May 2002.
Question: Is there a {numcases*} environment for unnumbered cases?
Answer: There is a {cases} environment in \texttt{AMSLATEX}, but it is just as convenient to stick with the canonical \LaTeX array:

\[
\begin{cases}
\text{left side} = \left\{ \begin{array}{l}
\text{right.}
\end{array} \right.
\end{cases}
\]

Speaking of \texttt{AMS-math}, they use an entirely different system of equation numbering, and this package uses ordinary \LaTeX numbering.

\[
\begin{numcases}{|x|=}
x, & for $x \geq 0$\nonumber \tag{1} \label{1} \\
\text{-}x, & for $x < 0$\nonumber \tag{2} \label{2}
\end{numcases}
\]

A simple example is:

\begin{numcases}{|x| =}
x, & for $x \geq 0$\nonumber \tag{1} \label{1} \\
\text{-}x, & for $x < 0$\nonumber \tag{2} \label{2}
\end{numcases}

Giving:

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

Another example is calculating the square root of $c + id$. First compute

\[
w \equiv \begin{cases}
0 & c = d = 0 \\
\sqrt{|c|} \sqrt{\frac{1 + \sqrt{1 + (d/c)^2}}{2}} & |c| \geq |d| \\
\sqrt{|d|} \sqrt{\frac{|c/d| + \sqrt{1 + (c/d)^2}}{2}} & |c| < |d|
\end{cases}
\]

Then, using $w$ from eq. \ref{3}, the square root is

\[
\sqrt{c + id} = \begin{cases}
0 & w = 0 \text{ (case 3a)} \\
w + \frac{d}{2w} & w \neq 0, c \geq 0 \\
\frac{|d|}{2w} + i w & w \neq 0, c < 0, d \geq 0 \\
\frac{|d|}{2w} - i w & w \neq 0, c < 0, d < 0
\end{cases}
\]
Another example is calculating the square root of $c+id$. First compute

$$
\begin{align*}
&w \equiv \\
&0 \quad \text{if } c = d = 0 \label{wzero} \\
&\sqrt{|c|} \sqrt{\frac{1 + \sqrt{1+(d/c)^2}}{2}} \quad \text{if } |c| \geq |d| \\
&\sqrt{|d|} \sqrt{\frac{|c/d| + \sqrt{1+(c/d)^2}}{2}} \quad \text{if } |c| < |d|
\end{align*}
$$

Then, using $w$ from eq.~(ef{w}), the square root is

$$
\begin{align*}
&\sqrt{c+id} = \\
&0 \quad \text{if } w=0 \text{ (case } \ref{wzero}) \\
&w + \frac{d}{2w} \quad \text{if } w \neq 0, c \geq 0 \\
&\frac{|d|}{2w} + iw \quad \text{if } w \neq 0, c < 0, d \geq 0 \\
&\frac{|d|}{2w} - iw \quad \text{if } w \neq 0, c < 0, d < 0
\end{align*}
$$