Entering Complex Numbers

Overview of Complex Numbers

A complex number has real and imaginary components that identify a point in the complex plane. These components are measured along the real and imaginary axes, which are similar to the x and y axes in the real plane.

The point can be expressed in rectangular form or in either of two polar forms.

The i symbol represents the imaginary number \( \sqrt{-1} \).

As shown below, the form that you can enter depends on the current Angle mode.

<table>
<thead>
<tr>
<th>You can use the form:</th>
<th>When the Angle mode setting is:</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a + bi )</td>
<td>Radian or Degree or Degrees</td>
</tr>
<tr>
<td>( r \theta )</td>
<td>Radian only</td>
</tr>
<tr>
<td>( (r \angle \theta) )</td>
<td>Radian or Degree</td>
</tr>
</tbody>
</table>

Use the following methods to enter a complex number.

To enter the: | Do this:
--- | ---
Rectangular form \( a + bi \) | Substitute the applicable values or variable names for \( a \) and \( b \).
\( a + bi \) | For example:
\[ 2 + 3i \]

Note: To get the i symbol, press [2nd] [i]. Do not simply type an alphabetic i.

Complex Format Mode for Displaying Results

Use \( \text{MODE} \) to set the Complex Format mode to one of three settings.

If Complex Format is: | The TI-89 / TI-92 Plus:
--- | ---
REAL | Will not display complex results unless you:
| | • Enter a complex number.
| | • Use a complex function such as cFactor(), cSolve(), or cZeros().
| | If complex results are displayed, they will be shown in either \( a + bi \) or \( r \theta \) form.
| POLAR | Displays complex results as \( a + bi \). |
| | \( r \angle \theta \) if the Angle mode = Radian
| | \( r \angle \theta \) if the Angle mode = Degrees

To enter the: | Do this:
--- | ---
Polar form \( r \theta \) | Substitute the applicable values or variable names for \( r \) and \( \theta \), where \( \theta \) is interpreted according to the Angle mode setting.
TI-89: | \[ \text{Re} \[ \theta \text{Polar} \] \]
| \( r \theta \) | \( r \theta \)
TI-89 Plus: | \[ \text{Re} \[ \theta \text{Polar} \] \]
| \( r \theta \) | \( r \theta \)
For example:

\[ 2 + 3i \]
\[ 2 \angle 45 \]

Results are shown in rectangular form, but you can select polar form.
Regardless of the Complex Format mode setting, undefined variables are treated as real numbers. To perform complex symbolic analysis, you can use either of the following methods to set up a complex variable.

**Method 1:** Use an underscore \( _- \) (TI-89: \( \text{[x]} \) \( \text{[.]}) \) as the last character in the variable name to designate a complex variable. For example:

\[
\begin{align*}
\text{imag}(z) & \quad \theta \\
\text{imag}(z_-) & \quad \text{imag}(z_-) \\
\text{imag}(z_) & \quad \text{imag}(z_+)
\end{align*}
\]

**Method 2:** Define a complex variable. For example:

\[
x + y \cdot i \rightarrow z
\]

Then \( z \) is treated as a complex variable.

Complex Numbers and Degree Mode

**Note:** If you use Degree angle mode, you must make polar entries in the form \((r \angle \theta)\). In Degree angle mode, an \( r \) entry causes an error.

Radian angle mode is recommended for complex number calculations. Internally, the TI-89 / TI-92 Plus converts all entered trig values to radians, but it does not convert values for exponential, logarithmic, or hyperbolic functions.

In Degree angle mode, complex identities such as \( e^{\alpha} (i\theta) = \cos(\theta) + i \sin(\theta) \) are not generally true because the values for \( \cos \) and \( \sin \) are converted to radians, while those for \( e^{\alpha} () \) are not. For example, \( e^{\alpha} (i45) = \cos(45) + i \sin(45) \) is treated internally as \( e^{\alpha}(i45) = \cos(\pi/4) + i \sin(\pi/4) \). Complex identities are always true in Radian angle mode.