The Complex Conjugate

Start

Start

Complex conjugates

Start

Complex conjugates

a pair of complex numbers,

▸ Start

Complex conjugates

a pair of complex numbers, both having the same real part,

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a pair of complex numbers, both having the same real part, but with imaginary parts of equal magnitude

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$ex)$ $1+2i, 1-2i$ are complex conjugates.

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The conjugate of the complex number $a+bi$

- $\overline{z \pm w} = \bar{z} \pm \overline{w}$ Proof
- $\overline{z \cdot w} = \bar{z} \cdot \overline{w}$ Proof
- $\overline{\left(\frac{z}{w}\right)} = \frac{\bar{z}}{\overline{w}}$ Proof
- $\bar{z} = z \;\Rightarrow\; z$ is a real number. Proof
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  Let $z = a_1 + b_1 i,\ w = a_2 + b_2 i\ (a_1,\ a_2,\ b_1,\ b_2 \in \mathbb{R})$

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&= (a_1 \pm a_2) - (b_1 \pm b_2) i \\
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&= (a_1 - b_1 i) \pm (a_2 - b_2 i) \\
&= \overline{a_1 + b_1 i} \pm \overline{a_2 + b_2 i} \\
&= \bar{z} \pm \overline{w}
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$$\begin{aligned} \overline{z \cdot w} &= \overline{(a_1 + b_1 i) \cdot (a_2 + b_2 i)} \\ &= \overline{(a_1 a_2 - b_1 b_2) + (a_1 b_2 + a_2 b_1) i} \end{aligned}$$

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&= (a_1 a_2 - b_1 b_2) - (a_1 b_2 + a_2 b_1) i \\
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&= (a_1 - b_1 i) \cdot (a_2 - b_2 i) \\
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$$\overline{\left(\frac{z}{w}\right)} = \overline{\frac{a_1 + b_1 i}{a_2 + b_2 i}} = \overline{\frac{a_1 a_2 - b_1 b_2}{a_2^2 + b_2^2} + \frac{-a_1 b_2 + a_2 b_1}{a_2^2 + b_2^2} i}$$

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&= \frac{a_1 a_2 - b_1 b_2}{a_2^2 + b_2^2} - \frac{-a_1 b_2 + a_2 b_1}{a_2^2 + b_2^2} i \\
&= \frac{a_1 a_2 - b_1 b_2}{a_2^2 + b_2^2} + \frac{a_1 b_2 - a_2 b_1}{a_2^2 + b_2^2} i \\
&= \frac{a_1 - b_1 i}{a_2 - b_2 i}
\end{aligned}$$

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$$= \frac{a_1 a_2 - b_1 b_2}{a_2^2 + b_2^2} + \frac{a_1 b_2 - a_2 b_1}{a_2^2 + b_2^2} i$$

$$= \frac{a_1 - b_1 i}{a_2 - b_2 i} = \frac{\overline{a_1 + b_1 i}}{\overline{a_2 + b_2 i}}$$

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Let $z = a_1 + b_1 i,\ w = a_2 + b_2 i\ (a_1,\ a_2,\ b_1,\ b_2 \in \mathbb{R})$

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&= \frac{a_1 a_2 - b_1 b_2}{a_2^2 + b_2^2} - \frac{-a_1 b_2 + a_2 b_1}{a_2^2 + b_2^2} i \\
&= \frac{a_1 a_2 - b_1 b_2}{a_2^2 + b_2^2} + \frac{a_1 b_2 - a_2 b_1}{a_2^2 + b_2^2} i \\
&= \frac{a_1 - b_1 i}{a_2 - b_2 i} = \frac{\overline{a_1 + b_1 i}}{\overline{a_2 + b_2 i}} = \frac{\bar{z}}{\bar{w}}
\end{aligned}$$

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- $\bar{z} = z \;\Rightarrow\; z$ is a real number.

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$$\bar{z} \quad = \quad z$$

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- $\bar{z} = z \;\Rightarrow\; z$ is a real number.

Let $z = a + bi (a, b \in \mathbb{R})$

$$\begin{aligned} \bar{z} &= z \\ \overline{a+bi} &= a + bi \end{aligned}$$

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Let $z = a + bi (a, b \in \mathbb{R})$

$$\begin{aligned} \bar{z} &= z \\ \overline{a+bi} &= a+bi \\ a-bi &= a+bi \\ 2bi &= 0 \end{aligned}$$

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$$\begin{aligned} \bar{z} &= z \\ \overline{a+bi} &= a+bi \\ a-bi &= a+bi \\ 2bi &= 0 \\ b &= 0 \end{aligned}$$

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$$\begin{aligned} \bar{z} &= -z \\ \overline{a+bi} &= -(a+bi) \\ a - bi &= -a - bi \end{aligned}$$

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- $\bar{z} = -z \;\Rightarrow\; z$ is an imaginary number.

Let $z = a + bi (a, b \in \mathbb{R})$

$$\begin{aligned} \bar{z} &= -z \\ \overline{a + bi} &= -(a + bi) \\ a - bi &= -a - bi \\ 2a &= 0 \end{aligned}$$

The Complex Conjugate

Start

- $\bar{z} = -z \;\Rightarrow\; z$ is an imaginary number.

Let $z = a + bi (a, b \in \mathbb{R})$

$$\begin{aligned} \bar{z} &= -z \\ \overline{a + bi} &= -(a + bi) \\ a - bi &= -a - bi \\ 2a &= 0 \\ a &= 0 \end{aligned}$$