켤레 복소수
(The Complex Conjugate)

Start End

Start End

Complex conjugates

Start End

Complex conjugates

a pair of complex numbers,

Start End

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

▸ Start ▸ End

Complex conjugates

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

Start End

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

Start End

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The conjugate of the complex number $a+bi$

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- $\overline{z \pm w} = \overline{z} \pm \overline{w}$ Proof

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- $\overline{z \pm w} = \overline{z} \pm \overline{w}$ Proof
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- $\overline{\left(\frac{z}{w}\right)}$

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- $\overline{\left(\frac{z}{w}\right)} = \frac{\overline{z}}{\overline{w}}$ Proof
- $\overline{\overline{z}} = z$

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Main Start End

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

Main Start End

- $\overline{z \pm w} = \overline{z} \pm \overline{w}$

$$\begin{aligned} \text{Let } z = a_1 + b_1 i,\ w = a_2 + b_2 i\ (a_1,\ a_2,\ b_1,\ b_2 \in \mathbb{R}) \\ \overline{z \pm w} &= \overline{(a_1 + b_1 i) \pm (a_2 + b_2 i)} \text{ (Double signs in same order)} \end{aligned}$$

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$$

$$
\begin{aligned}
\overline{z \pm w} &= \overline{(a_1 + b_1 i) \pm (a_2 + b_2 i)} \text{ (Double signs in same order)} \\
&= \overline{(a_1 \pm a_2) + (b_1 \pm b_2) i} \\
&= (a_1 \pm a_2) - (b_1 \pm b_2) i \\
&= (a_1 - b_1 i) \pm (a_2 - b_2 i)
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▸ Main ▸ Start ▸ End

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$$\begin{aligned} \overline{z \pm w} &= \overline{(a_1 + b_1 i) \pm (a_2 + b_2 i)} \text{ (Double signs in same order)} \\ &= \overline{(a_1 \pm a_2) + (b_1 \pm b_2) i} \\ &= (a_1 \pm a_2) - (b_1 \pm b_2) i \\ &= (a_1 - b_1 i) \pm (a_2 - b_2 i) \\ &= \overline{a_1 + b_1 i} \pm \overline{a_2 + b_2 i} \end{aligned}$$

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\overline{z \pm w} &= \overline{(a_1 + b_1 i) \pm (a_2 + b_2 i)} \text{ (Double signs in same order)} \\
&= \overline{(a_1 \pm a_2) + (b_1 \pm b_2) i} \\
&= (a_1 \pm a_2) - (b_1 \pm b_2) i \\
&= (a_1 - b_1 i) \pm (a_2 - b_2 i) \\
&= \overline{a_1 + b_1 i} \pm \overline{a_2 + b_2 i} \\
&= \overline{z} \pm \overline{w}
\end{aligned}
$$

The Complex Conjugate

Main Start End

- $\overline{z \cdot w} = \overline{z} \cdot \overline{w}$

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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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$$\overline{z \cdot w} = \overline{(a_1 + b_1 i) \cdot (a_2 + b_2 i)}$$

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

▸ Main ▸ Start ▸ End

- $\overline{z \cdot w} = \overline{z} \cdot \overline{w}$

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\begin{aligned}
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\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} \\
&= (a_1 a_2 - b_1 b_2) - (a_1 b_2 + a_2 b_1) i
\end{aligned}
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\overline{z \cdot w} &= \overline{(a_1 + b_1 i) \cdot (a_2 + b_2 i)} \\
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&= (a_1 - b_1 i) \cdot (a_2 - b_2 i)
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▸ Main ▸ Start ▸ End

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

Main Start End

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$$\overline{\left(\frac{z}{w}\right)} = \overline{\frac{a_1 + b_1 i}{a_2 + b_2 i}}$$

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

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

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- $\overline{\left(\dfrac{z}{w}\right)} = \dfrac{\overline{z}}{\overline{w}}$

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

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

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

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

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

▸ Main ▸ Start ▸ End

- $\overline{\left(\dfrac{z}{w}\right)} = \dfrac{\overline{z}}{\overline{w}}$

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

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

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- $\overline{\left(\dfrac{z}{w}\right)} = \dfrac{\overline{z}}{\overline{w}}$

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

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

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

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

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

Main Start End

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

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

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

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

Main Start End

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

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

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

▸ Main ▸ Start ▸ End

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

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

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

Main Start End

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

$$
\begin{aligned}
\text{Let } z &= a + bi (a, b \in \mathbb{R}) \\
\overline{z} &= z \\
\overline{a + bi} &= a + bi \\
a - bi &= a + bi \\
2bi &= 0
\end{aligned}
$$

Main Start End

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

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

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

Main Start End

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

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Main Start End

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

  $$\overline{z} = -z$$

▸ Main ▸ Start ▸ End

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

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

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

Main Start End

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

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

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

Main Start End

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

$$\begin{aligned}
\text{Let } z &= a + bi (a, b \in \mathbb{R}) \\
\overline{z} &= -z \\
\overline{a + bi} &= -(a + bi) \\
a - bi &= -a - bi \\
2a &= 0
\end{aligned}$$

Main Start End

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

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

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

Github:
https://min7014.github.io/math20210126001.html

Click or paste URL into the URL search bar, and you can see a picture moving.