

A Book of Abstract Algebra | (2nd Edition)

Chapter 31, Problem 1EA

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Problem

Show that $\mathbb{Q}(\sqrt{3}, i)$ is the root field of $(x^2 - 2x - 2)(x^2 + 1)$ over \mathbb{Q} .

Comparing part 1 with the example, we note that different polynomials may have the same root field. This is true even if the polynomials are irreducible.

Step-by-step solution

Step 1 of 2

The objective is to show that $\mathbb{Q}(\sqrt{3}, i)$ is the root field of $(x^2 - 2x - 2)(x^2 + 1)$ over \mathbb{Q} .

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Step 2 of 2

Let $a(x) = (x^2 - 2x - 2)(x^2 + 1)$.

Use the formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ to find roots of $x^2 - 2x - 2$.

Here, $a=1$, $b=-2$, and $c=-2$.

$$\begin{aligned}x &= \frac{-(-2) \pm \sqrt{(-2)^2 - 4 \cdot 1 \cdot (-2)}}{2 \cdot 1} \\&= \frac{2 \pm \sqrt{12}}{2} \\&= 1 \pm \sqrt{3}\end{aligned}$$

The roots of $x^2 + 1$ are $\pm i$.

The roots of $a(x) = (x^2 - 2x - 2)(x^2 + 1)$ are $1 \pm \sqrt{3}$, $\pm i$.

Therefore, the root field is $\mathbb{Q}(1 \pm \sqrt{3}, \pm i)$. This can be written simply as $\mathbb{Q}(\sqrt{3}, i)$.

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