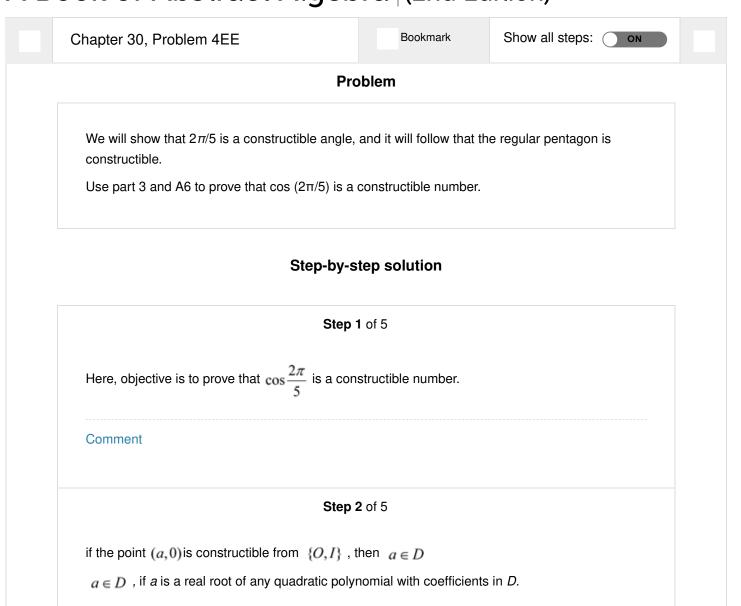
A Book of Abstract Algebra (2nd Edition)



De Moivre's theorem: $\omega = \cos \frac{2\pi}{5} + i \sin \frac{2\pi}{5}$ is a complex fifth root of unity.

Since $x^5 - 1 = (x - 1)(x^4 + x^3 + x^2 + x + 1)$. ω is a root of $P(x) = (x^4 + x^3 + x^2 + x + 1)$

Comment

Step 3 of 5

Consider
$$\omega = \cos \frac{2\pi}{5} + i \sin \frac{2\pi}{5}$$

$$\frac{1}{\omega} = \cos\frac{2\pi}{5} - i\sin\frac{2\pi}{5}$$

$$\left(\omega + \frac{1}{\omega}\right) = 2\cos\frac{2\pi}{5}$$

Comment

Step 4 of 5

Consider ω is a root of $P(x) = (x^4 + x^3 + x^2 + x + 1)$

Then,

$$(\omega^4 + \omega^3 + \omega^2 + \omega + 1) = 0$$

$$\omega^2 + \omega + 1 + \omega^{-1} + \omega^{-2} = 0$$

$$\left(\omega + \frac{1}{\omega}\right)^2 + \left(\omega + \frac{1}{\omega}\right) - 1 = 0$$

$$\left(2\cos\frac{2\pi}{5}\right)^2 + \left(2\cos\frac{2\pi}{5}\right) - 1 = 0$$

$$4\cos^2\frac{2\pi}{5} + 2\cos\frac{2\pi}{5} - 1 = 0$$

Comment

Step 5 of 5

Consider the polynomial $4x^2 - 2x - 1$

put $x = 2\cos\frac{2\pi}{5}$ in above equation, then

$$4x^2 - 2x - 1 =$$

$$=4\cos^2\frac{2\pi}{5} + 2\cos\frac{2\pi}{5} - 1$$

= (

Hence, $\cos \frac{2\pi}{5}$ is a root of quadratic polynomial $4x^2 - 2x - 1 = 0$, then $\cos \frac{2\pi}{5} \in D$

Therefore, $\cos \frac{2\pi}{5}$ is a constructible from $\{O, I\}$.

Hence, proved.

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