

A Book of Abstract Algebra | (2nd Edition)



Chapter 30, Problem 4EC



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Problem

An angle α is called *constructible* iff there exist constructible points A , B , and C such that $\angle ABC = \alpha$.

Prove the following:

$$\cos(2\alpha) \in \mathbb{D} \text{ iff } \cos \alpha \in \mathbb{D}.$$

Step-by-step solution

Step 1 of 3

Here, objective is to prove that $\cos 2\alpha \in D$, if and only if $\cos \alpha \in D$

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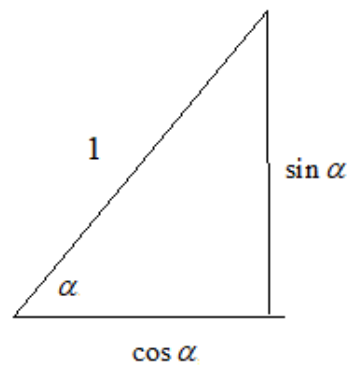
Step 2 of 3

Constructible point is the end point of given unit segment or it is intersection of two lines determined by constructional points.

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Step 3 of 3

Consider the below figure:



Consider $\cos \alpha \in D$, then the point $(\cos \alpha, 0)$ is constructible from $\{O, I\}$

$$\cos(2\alpha) = 2\cos^2 \alpha - 1$$

If $\cos \alpha$ is constructible then $\cos 2\alpha$ is also constructible.

If $\cos 2\alpha$ is constructible then $\cos 2\alpha \in D$.

Therefore, $\cos(\alpha + \beta), \cos(\alpha - \beta) \in D$, if $\cos \alpha, \cos \beta \in D$.

Hence, proved

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