

Homework for April 7, 2024.

Algebra/Geometry. Complex numbers.

Please, complete the previous homework assignments. Review the classwork handout on complex numbers. Solve the following problems.

Problems.

- (i) find the magnitude and the argument, (ii) compute the inverse, and (iii) find the magnitude and the argument of the inverse for the following complex numbers:
 - $1 + i$
 - $-i$
 - $1 + ix$
 - $\frac{\sqrt{3}}{2} + \frac{i}{2}$
 - $\frac{1}{2-i} - \frac{1}{2+i}$
- Find a complex number z whose magnitude is 2 and the argument $Arg(z) = \frac{\pi}{4} = 45^\circ$.
- Draw the following sets of points on complex plane.
 - $\{z | Re(z) = 1\}$
 - $\{z | Arg(z) = \frac{3\pi}{4} = 135^\circ\}$
 - $\{z | |z| = 1\}$
 - $\{z | Re(z^2) = 0\}$
 - $\{z | |z^2| = 2\}$
 - $\{z | |z - 1| = 1\}$
 - $\{z | z + \bar{z} = 1\}$
- Prove that for any complex number z , we have
 - $|\bar{z}| = |z|, Arg(\bar{z}) = -Arg(z)$
 - $\frac{\bar{z}}{z}$ has magnitude 1; check this for $z = 1 - i$.
- If z has magnitude 2 and argument $\frac{\pi}{2}$ and w has magnitude 3 and argument $\frac{\pi}{3}$, what will be the magnitude and the argument of zw ? Write it in the form $a + bi$.
- Let $P(x)$ be a polynomial with real coefficients.
 - Prove that for any complex number z , we have $\overline{P(z)} = P(\bar{z})$

- b. Let z be a complex root of this polynomial, $P(z) = 0$. Prove that then \bar{z} is also a root, $P(\bar{z}) = 0$.
7. Solve the equation $x^3 - 4x^2 + 6x - 4 = 0$. Find the sum and product of the roots in two ways: by using Vieta formulas and by explicit computation. Check that the results match.
8. Simplify following expression:
- $(1 + \sin \alpha)(1 - \sin \alpha)$
 - $(1 + \cos \alpha)(1 - \cos \alpha)$
 - $\sin^4 \alpha - \cos^4 \alpha$
9. Prove the following equalities:
- $\cos 3\alpha = 4 \cos^3 \alpha - 3 \cos \alpha$
 - $\sin 3\alpha = 3 \sin \alpha - 4 \sin^3 \alpha$
 - $\cos 4\alpha = 8 \cos^4 \alpha - 8 \cos^2 \alpha + 1$
 - $\sin 4\alpha = 4 \sin \alpha \cos^3 \alpha - 4 \cos \alpha \sin^3 \alpha$
 - $\sin 5\alpha = 16 \sin^5 \alpha - 20 \sin^3 \alpha + 5 \sin \alpha$
 - $\cos 5\alpha = \dots$ (find the expression)
10. Solve the following equation:
- $\cos^2 \pi x + 4 \sin \pi x + 4 = 0$
11. Solve the following equations and inequalities:
- $\sin x + \sin 2x + \sin 3x = \cos x + \cos 2x + \cos 3x$
 - $\cos 3x - \sin x = \sqrt{3}(\cos x - \sin 3x)$
 - $\sin^2 x - 2 \sin x \cos x = 3 \cos^2 x$
 - $\sin 6x + 2 = 2 \cos 4x$
 - $\cot x - \tan x = \sin x + \cos x$
 - $\sin x \geq \pi/2$
 - $\sin x \leq \cos x$