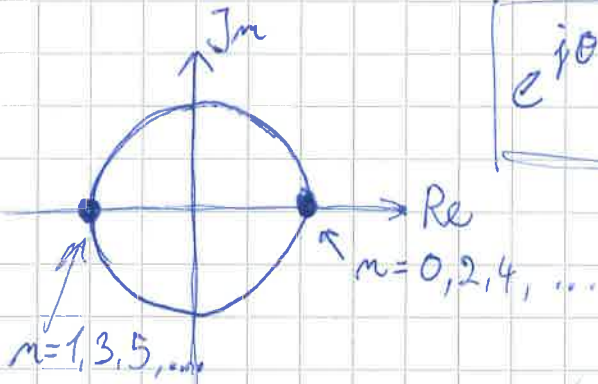


HARJOITUSTEHTÄVÄT 2

T1) ESITÄ SEURAAVAT KOMPLEKSILUVUT REAALI- JA IMAGINAARIOSAN AVULLA (KARTEESINEN MUOTO)

a) $z = e^{jm\pi}$, m ON PARITON KOKONAISLUKU



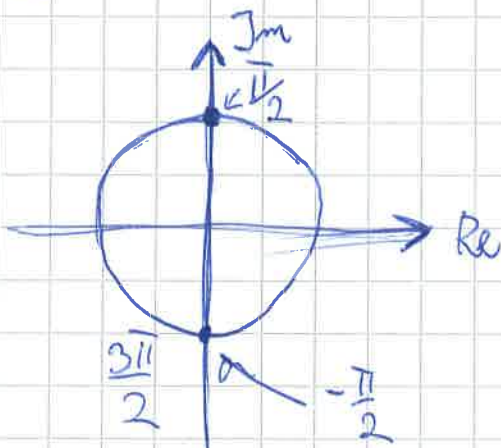
$$e^{j\theta} = \cos(\theta) + j\sin(\theta)$$

$$\underline{z} = \underbrace{\cos(m\pi)}_{=-1} + j\underbrace{\sin(m\pi)}_{=0} = -1 + 0 \cdot j = \underline{-1}$$

b) $z = e^{jn\pi}$, n ON PARILLINEN KOKONAISLUKU

$$\underline{z} = \underbrace{\cos(n\pi)}_{=1} + j\underbrace{\sin(n\pi)}_{=0} = 1 + 0 \cdot j = \underline{1}$$

c) $z = e^{j\pi/2}$

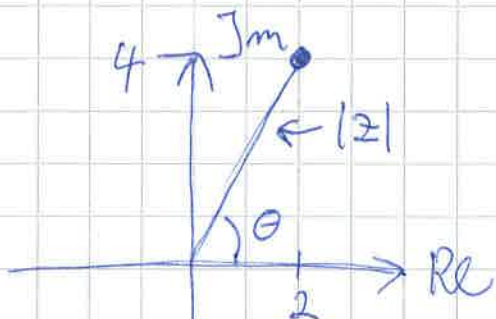


$$\underline{z} = \underbrace{\cos(\frac{\pi}{2})}_{=0} + j\underbrace{\sin(\frac{\pi}{2})}_1 = 0 + 1 \cdot j = j$$

HARJOITUSTEHTÄVÄT 2,

(T2) ESITÄ SEURAAVAT KOMPLEKSI LUVUT
OSOITIN MUODOSSA

a) $z = 2 + 4j$



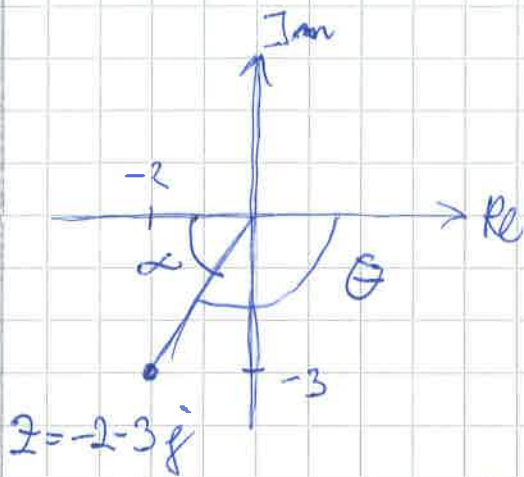
$$z = |z|e^{j\theta} \text{ (OSOITIN MUOTO)}$$

$$|z| = \sqrt{2^2 + 4^2} = \sqrt{20}$$

$$\theta = \tan^{-1}\left(\frac{4}{2}\right) = 63.43^\circ = \frac{63.43^\circ}{180^\circ} \cdot \pi = 1.107$$

$$\underline{\underline{z = \sqrt{20}e^{j \cdot 1.107}}}$$

(T2) c) $z = -2 - 3j$



$$\alpha = \tan^{-1} \frac{|-3|}{|-2|} = 56.31^\circ$$

$$\Theta = -(180^\circ - 56.31^\circ) = -123.69^\circ = -2.159 \text{ (RAD)}$$

$$|z| = \sqrt{(-2)^2 + (-3)^2} = \sqrt{13}$$

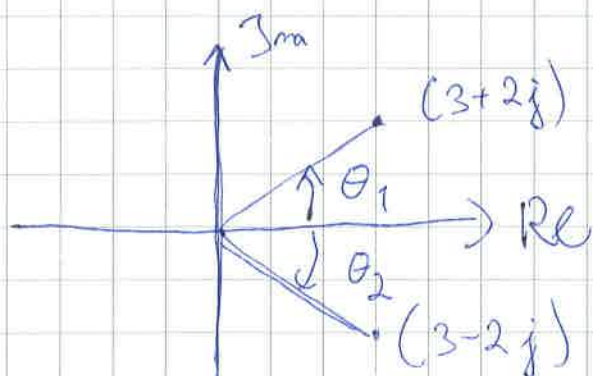
$$z = \sqrt{13} e^{-j2.159}$$

TS

$$x(t) = z_1 e^{j2t} + z_2 e^{-j2t} \quad ; z_1 = 3+2j, z_2 = 3-2j$$

$$= (3+2j)e^{j2t} + (3-2j)e^{-j2t}$$

$$|z_1| = |z_2| = \sqrt{3^2 + 2^2} = \sqrt{13}$$



$$\theta_1 = -\theta_2 = \tan^{-1}\left(\frac{2}{3}\right) = 33.7^\circ = 0.588$$

$$x(t) = \sqrt{13} e^{j0.588} e^{j2t} + \sqrt{13} e^{-j0.588} e^{-j2t}$$

$$= \sqrt{13} \left(e^{j(2t+0.588)} + e^{-j(2t+0.588)} \right)$$

OTETAAN KÄYTTÖÖN YHTÄPITÄVYYS

$$\cos \theta = \frac{1}{2} (e^{j\theta} + e^{-j\theta})$$

$$\Rightarrow x(t) = \underbrace{2 \cdot \sqrt{13}}_{A} \cdot \underbrace{\frac{1}{2}}_{\cos} \left(e^{j(2t+0.588)} + e^{-j(2t+0.588)} \right)$$

$$= 2 \cdot \sqrt{13} \cos(2t+0.588)$$

$$A = 2\sqrt{13} \quad ; \omega = 2\pi f = 2 \Rightarrow f = \frac{1}{\pi} \quad ; \quad \theta = 33.7^\circ \quad (0.588 \text{ RAD})$$