



1)

$$a) x(t) = \cos(2\pi \cdot 100t) + \cos(2\pi \cdot 1200t)$$

$$x(n) \Big|_{t = T_{\text{samp}} \cdot n}$$

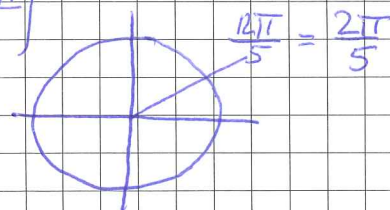
$$= \cos\left(\frac{2\pi \cdot 100n}{1000}\right) + \cos\left(\frac{2\pi \cdot 1200n}{1000}\right)$$

$$= \cos\left(\frac{\pi n}{5}\right) + \cos\left(\frac{12\pi n}{5}\right)$$

$$x(n) = \cos\left(\frac{\pi n}{5}\right) + \cos\left(\frac{2\pi n}{5}\right)$$

Etter LP-filter

$$y(t) = \cos(2\pi \cdot 100t) + \cos(2\pi \cdot 200t)$$



$$b) x(n) = \{1, 2, 3, 4, 2, 0, -2, -4\}$$

$$h(n) = \{1, -1\}$$

$$y(n) = x(n) * h(n)$$

$$= 1, 2, 3, 4, 2, 0, -2, -4$$

$$-1, -2, -3, -4, -2, 0, 2, 4$$

$$= 0, 0, 0, 0, 0, 0, 0, 0 \quad \Sigma = 0$$

Dette filteret nullstiller signalet. Det subtraherer signalet med seg selv.

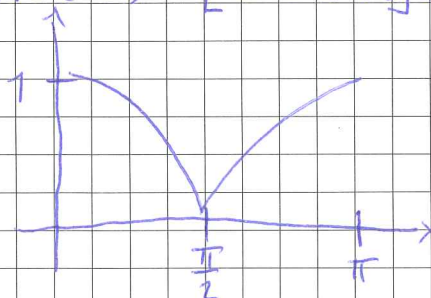
$$\text{Signal} + \text{invers signal} = 0$$

$$c) |H(\omega T)| = [\cos(\omega T)] e^{-j\omega T}$$

$$|H(0)| = 1$$

$$|H(\frac{\pi}{2})| = 0$$

$$|H(\pi)| = 1$$



Amplituderrespons



Fortsettelse
oppgave c)

$$H(\omega T) = [\cos(\omega T)] e^{-j\omega T}$$

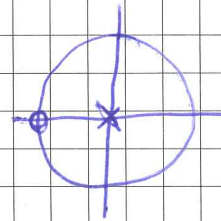
$$H(\omega T) = \frac{1}{2} [e^{j\omega T} + e^{-j\omega T}] e^{-j\omega T}$$

$$= \frac{1}{2} [1 + e^{-2j\omega T}]$$

$$H(z) = \frac{1}{2} [1 + z^{-2}]$$

$$= \frac{1}{2} \frac{z^2 + 1}{z^2}$$

Nullpunkter : 2x i -1
 Poler : 2x i 0



d) $f_s = 10 \text{ kHz}$

$f_g = 3 \text{ kHz}$

$f_d = 4 \text{ kHz} < 40 \text{ dB demping}$

$$n = \frac{1}{\tan \frac{2\pi \cdot 10000}{2 \cdot 10000}} = 0.727$$

$$\omega_n = 0.727 \cdot \tan \frac{2\pi \cdot 4000}{2 \cdot 10000} = 2.237$$

$$10 \log(1 + (2.237)^{2N})$$

→ generell formel, setter inn forshyellig
 N for å finne orden med
 mer enn 40 dB demping

$N = 4 \Rightarrow 27.98 \text{ dB}$

$N = 5 \Rightarrow 34.97 \text{ dB}$

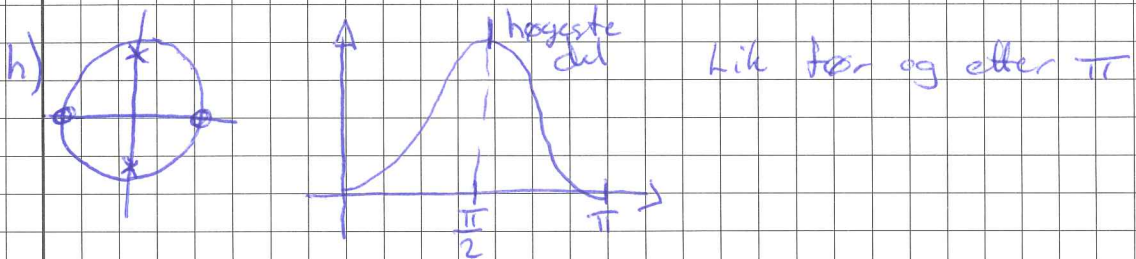
$N = 6 \Rightarrow 41.96 \text{ dB} - \text{over } 40 \text{ dB}$

laveste orden er 6. orden for å få mer enn
 40 dB demping

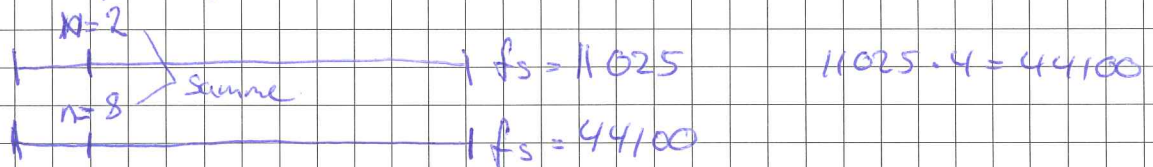


7.

e) $x(n) = \cos\left(\frac{\pi n}{4}\right)$
 $h(n) = \{-1, 0, 2, 0, -1\}$
 $y(n) = x(n) * h(n)$
 $= -\cos\left(\frac{\pi n}{4}\right) + 0 + 2\cos\left(\frac{\pi n}{4}\right) + 0 - \cos\left(\frac{\pi n}{4}\right)$
 $y(n) = \{-1, 0, -\sqrt{2}, 0, 1\}$



i) Det er bare å multipliser samplene med 4. Området er ikke stort, det er bare antallet sampler per tidsenhet som har økt



j) Da trenger du ett høypassfilter for å fremheve konturene.

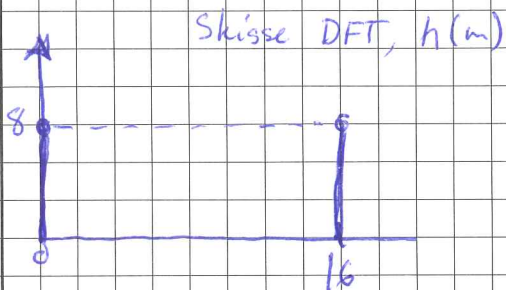
Kjerne

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

= Dette vil fremheve kanter på bildet og gjøre det skarper

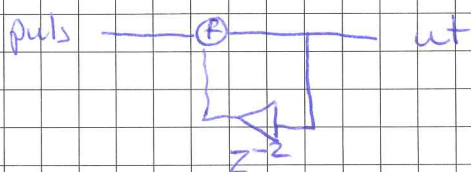


7 f)



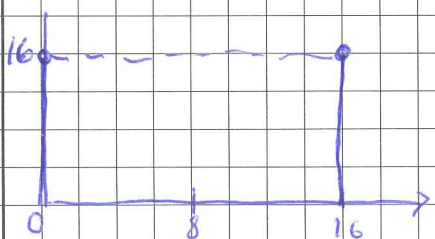
g)

Krets



$$|H(\omega T)| \quad H(z) = 1 + z^{-2} \\ = \frac{z^2 + 1}{z^2}$$

$$H(\omega T) = [2 \cos(\omega T)] e^{-j\omega T}$$



$|H(m)|$