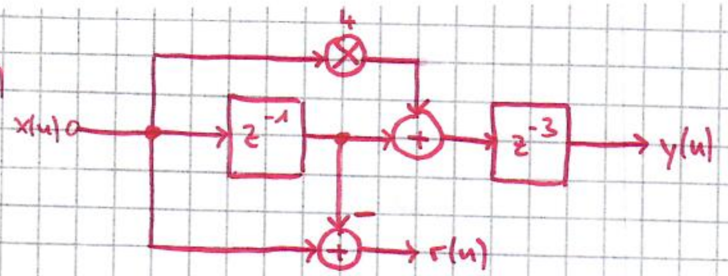
1.

Musterlösung

a) (2P)



(r(n) könnte auch separat)

b) (1P)

$y(n) = 4\,x(n-3) + x(n-4)$

$r(n) = x(n) - x(n-1)$

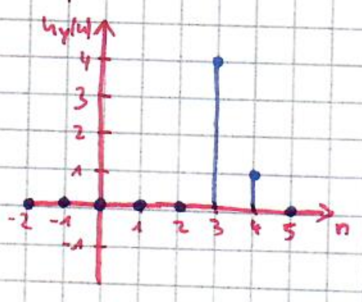
c) (1P)

$y(n) - r(n) = -x(n) + x(n-1) + 4x(n-3) + x(n-4)$

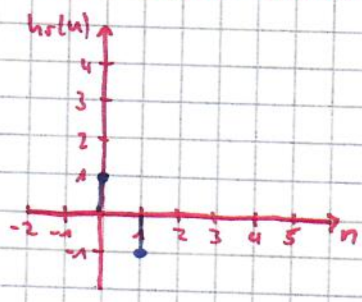
$$Y(z) - R(z) = X(z)\underbrace{\left(-1 + z^{-1} + 4z^{-3} + z^{-4}\right)}_{H(z)}$$

d) (1P)

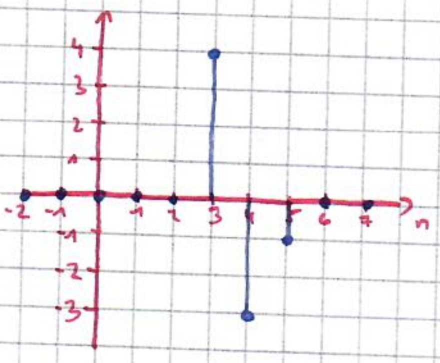
$h_y(n) = 4\delta(n-3) + \delta(n-4)$



$h_r(n) = \delta(n) - \delta(n-1)$



e) (1P)



(2P) f) $g(n) = \delta(n) + 2\delta(n-1) + \alpha \cdot \delta(n-2)$

(1P) g) $G(z) = 1 + 2z^{-1} + \alpha \cdot z^{-2}$

$G(e^{j\frac{\pi}{2}}) = 1 + 2 \cdot e^{-j\frac{\pi}{2}} + \alpha \cdot e^{-j\pi} = 1 - 2j - \alpha \overset{!}{=} -\frac{1}{16} - 2j$

$\Rightarrow \alpha = \frac{17}{16}$

(2P) h) $H_2(z) = \dfrac{1 + 2z^{-1} + \alpha z^{-2}}{z - \frac{3}{4}e^{j2\pi}} = \dfrac{1(z^2 + 2z + \alpha)}{z^2 \cdot (z - \frac{3}{4}e^{j2\pi})}$

$z_{\infty,1} = 0$ (zweifach)

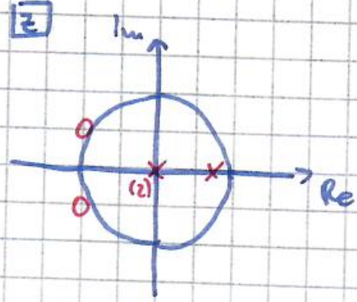
$z_{\infty,2} = \frac{3}{4}e^{j2\pi} = \frac{3}{4}$

$z_{0,1/2} = -\frac{2}{2} \pm \sqrt{1-\alpha}$

$= -1 \pm \sqrt{1 - \frac{17}{16}}$

$= -1 \pm \sqrt{-\frac{1}{16}}$

$= -1 \pm \frac{1}{4}j$



(1P) i) TP

(1P) j)

ROC: $0 < |z| < \frac{3}{4}$ (beidseitige)

ROC: $|z| > \frac{3}{4}$ (rechtsseitige)

2 a) Das System ist stabil, da es sich um ein kausales System mit allen Polstellen innerhalb des EHK handelt.

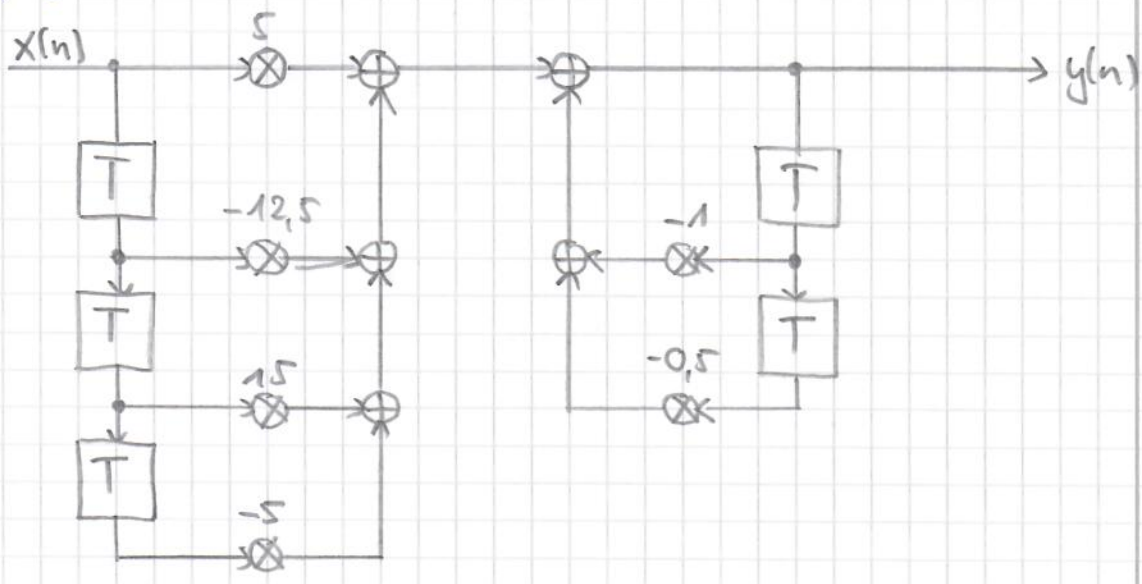
b) $$G(z) = \frac{(z-0{,}5)\,(z-(1+j))\cdot(z-(1-j))}{(z)\,(z-(-0{,}5+0{,}5j))\cdot(z-(-0{,}5-0{,}5j))}\cdot b_0$$

$$= \frac{-z^{-3}+3z^{-2}-2{,}5z^{-1}+1}{0{,}5z^{-2}+z^{-1}+1}\cdot b_0$$

$G(z=1) \overset{!}{=} 1 \rightarrow b_0 = \underline{\underline{5}}$

c) $y(n) = \cancel{5(x}\; 5x(n) - 12{,}5\,x(n-1) + 15\,x(n-2) - 5\,x(n-3)$
$\quad - y(n-1) - 0{,}5\,y(n-2)$

d) DF1



e) $$G_{AP} = \frac{(z-(1+j))\cdot(z-(1-j))}{(z-(0{,}5-0{,}5j))\,(z-(0{,}5+0{,}5j))}$$

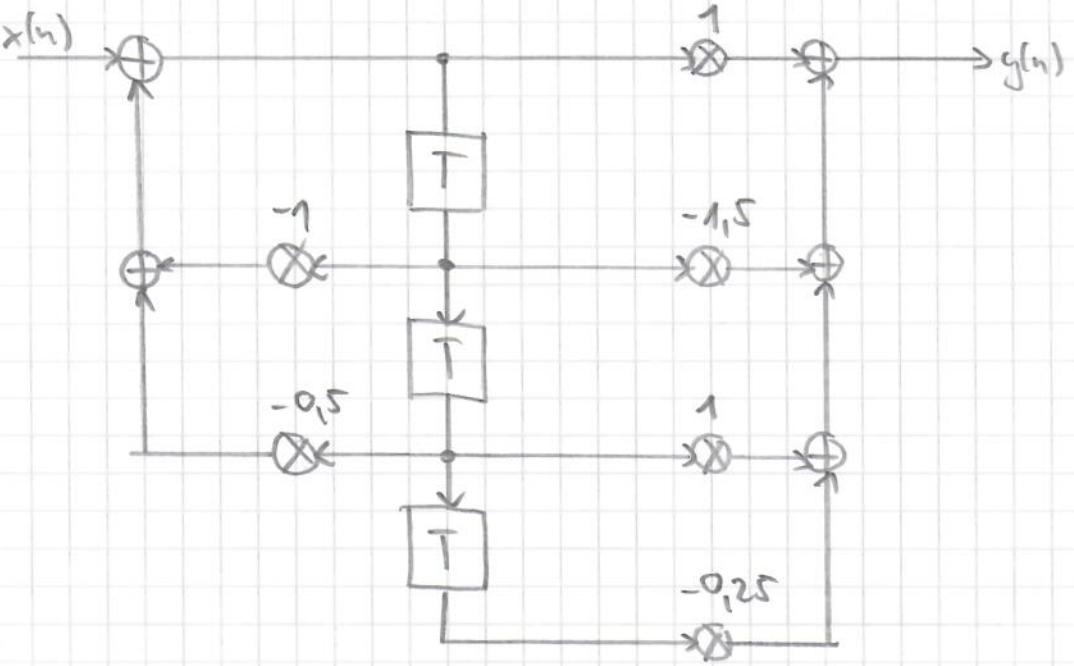
$$G_{MW} = \frac{(z-0{,}5)\,(z-(0{,}5-0{,}5j))\,(z-(0{,}5+0{,}5j))}{(z)\,(z-(-0{,}5+0{,}5j))\cdot(z-(-0{,}5-0{,}5j))}$$

g) $G_{MW} = \dfrac{-0{,}25\,z^{-3} + z^{-2} - 1{,}5\,z^{-1} + 1}{0{,}5\,z^{-2} + z^{-1} + 1}$

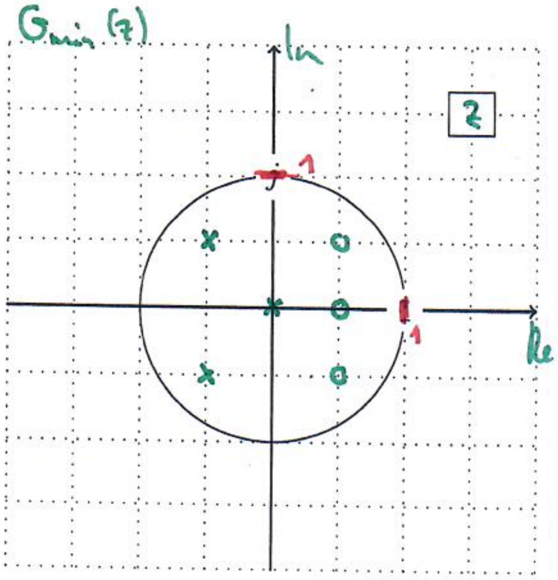
$y(n) = x(n) - 1{,}5\,x(n-1) + x(n-2) - 0{,}25\,x(n-3) - 0{,}5\,y(n-2)$

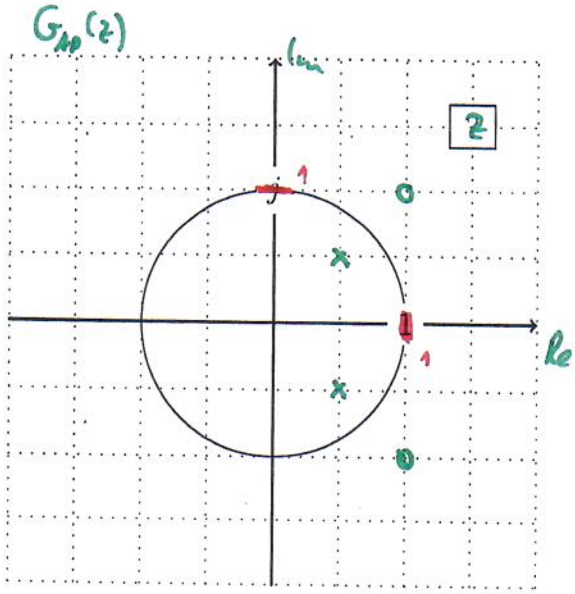
$- y(n-1)$

h)



i) Hochpass, Nullstellen rechts im PN-Diagramm und Pole links.





g) Geben Sie die Differenzengleichung für das Ausgangssignal $y_{\min}(n)$ des minimalphasigen Systems an.

h) Zeichnen Sie das Blockschaltbild des minimalphasigen Systems als Direktform II. Achten Sie auf vollständige Beschriftung (inklusive Zahlenwerte der Koeffizienten).

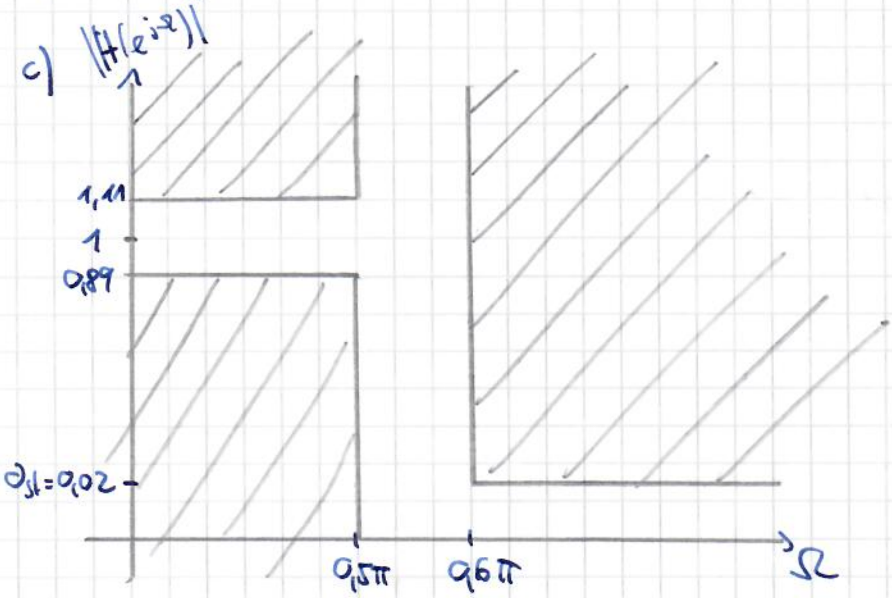
i) Welche Übertragungscharakteristik (Tiefpass, Hochpass, Bandpass, Bandsperre) weist das durch $G(z)$ beschriebene System auf? Begründen Sie Ihre Antwort kurz!

3a) $\delta_p = 0{,}11$ $\Omega_p = 0{,}5\pi$

$\delta_{st} = 0{,}02$ $\Omega_{st} = 0{,}6\pi$

b) Tiefpass

c)



d) $R_p = 20\log(1+\delta_p) - 20\log(1-\delta_p) \approx 1{,}9187$

$d_{st} = -20\log(\delta_{st}) \approx 33{,}9794$

e) Blackman, Hamming, Hann ~~ist~~ erfüllen Sperrdämpfung von min 34 dB!

f) $d = -20\log(\min\{\delta_p, \delta_{st}\}) = 33{,}9794$

$\Delta\Omega = 0{,}1\pi$

$\beta = 0{,}5842 \cdot (33{,}9794 - 21)^{0{,}4} + 0{,}07886 \cdot (33{,}9794 - 21)$

$= 2{,}6523$

g) $N_b \geq \dfrac{33{,}9794 - 7{,}95}{2{,}29 \cdot 0{,}1\pi} = 36{,}18$

$\Rightarrow N_b = 37$

4.

(1P) a) $f_s = \frac{7680.000\ \text{Bit}}{8\ \text{Bit}} \cdot \frac{1}{60s} = 16.000\ \frac{1}{s} = 16\ \text{kHz}$

(1P) b) $f_s'' = \frac{38.400.000\ \text{Bit}}{16\ \text{Bit}} \cdot \frac{1}{60s} = 40.000\ \frac{1}{s} = 40\ \text{kHz}$

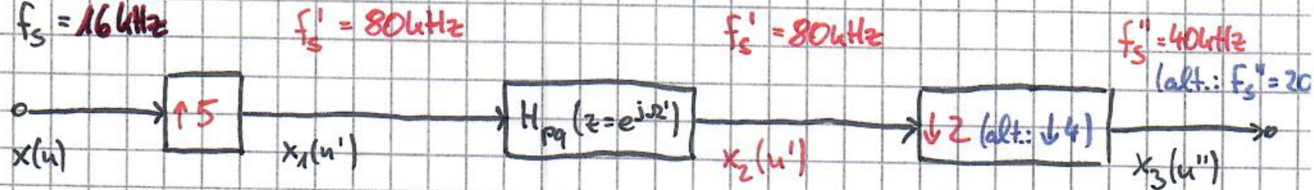
(1P) c) $r = \frac{5}{2}$ (alt.: $r = \frac{5}{4}$)

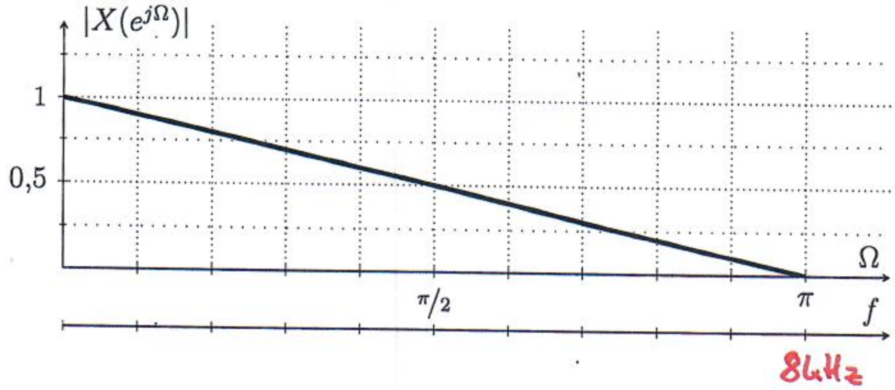
(1P) d) $f_{c,p} = 8\ \text{kHz}$ (alt.: $f_{c,p} = 8\ \text{kHz}$)

(1P) e) $\Omega_{c,q} = \frac{\pi}{2}$ (alt.: $\Omega_{c,q} = \frac{\pi}{4}$)

(1P) f) $\Omega_{c,pq} = \frac{\pi}{5}$ (alt.: $\Omega_{c,pq} = \frac{\pi}{5}$)

(2P) g) $f_s = 16\ \text{kHz}$





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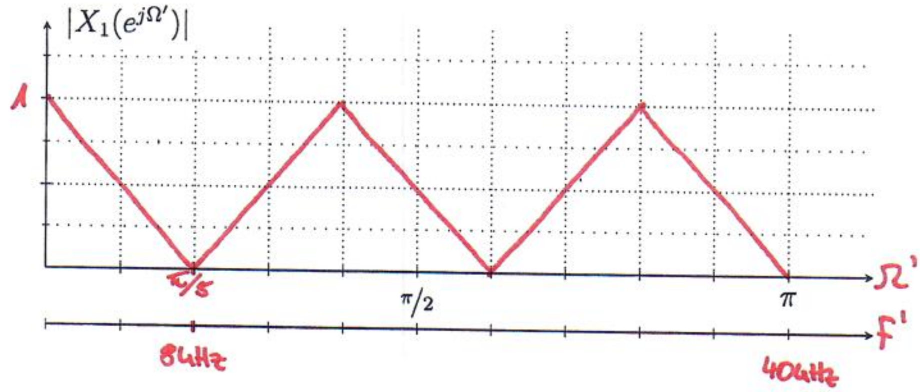
1,5P



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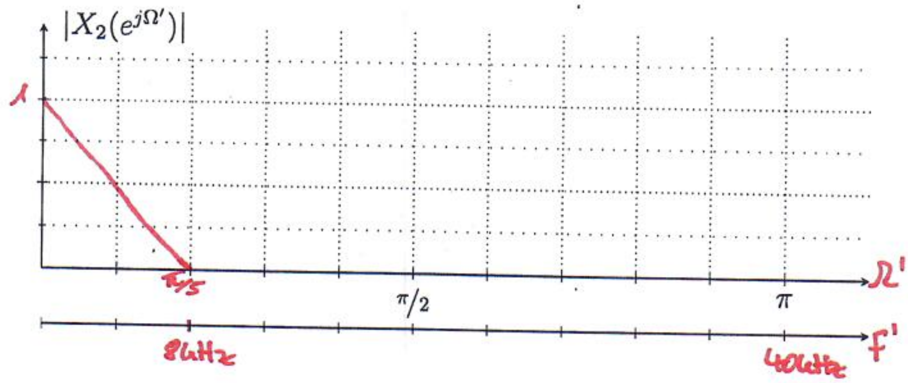
1P



❸

1,5 P