C4)4 T1

$$y(n) = a \cdot y(n-1) + x(n) + 0.9\, x(n-1)$$

$$\left[b^n\, \varepsilon(n) \circ\!\!-\!\!\bullet \frac{1}{1 - b z^{-1}} \right]$$

$$Y(z) = a z^{-1} Y(z) + X(z) + 0.9 z^{-1} X(z)$$

$$Y(z)(1 - a z^{-1}) = X(z)(1 + 0.9 z^{-1})$$

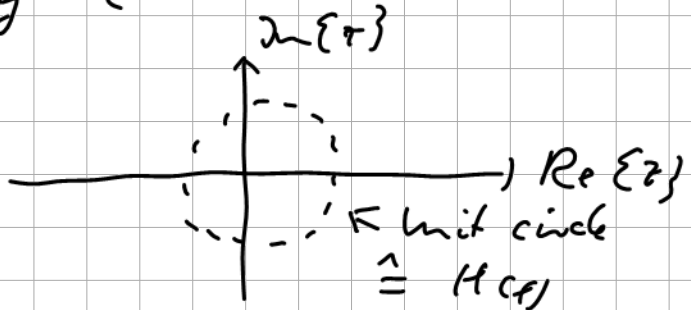
$$H(z) = \frac{Y(z)}{X(z)} = \frac{1 + 0.9 z^{-1}}{1 - a z^{-1}}$$

$$H(f) = \frac{1 + 0.9\, e^{-j2\pi f T}}{1 - a\, e^{-j2\pi f T}}$$

Task $H(z)$ is given, $H(f)$ is wanted:

z is replaced by $e^{j2\pi f T}$

(setting $|z| = 1$)



$h(n) = ?$

$$H(z) = \frac{1}{1 - a z^{-1}} + 0.9 z^{-1} \frac{1}{1 - a z^{-1}}$$

damping; fine delay

$$h(n) = a^n \varepsilon(n) + 0.9 \cdot a^{n-1} \varepsilon(n-1)$$

unit step $\varepsilon(n) = \begin{cases} 1, & n \geq 0 \\ 0, & \text{else} \end{cases}$

$h(-1) = 0$

$h(0) = a^0 = 1$

$h(1) = a^1 + 0.9 \cdot a^0 = a + 0.9$

$$h_{(2)} = a^2 + 0.9 \cdot a^1 = a^2 + 0.9\,a$$

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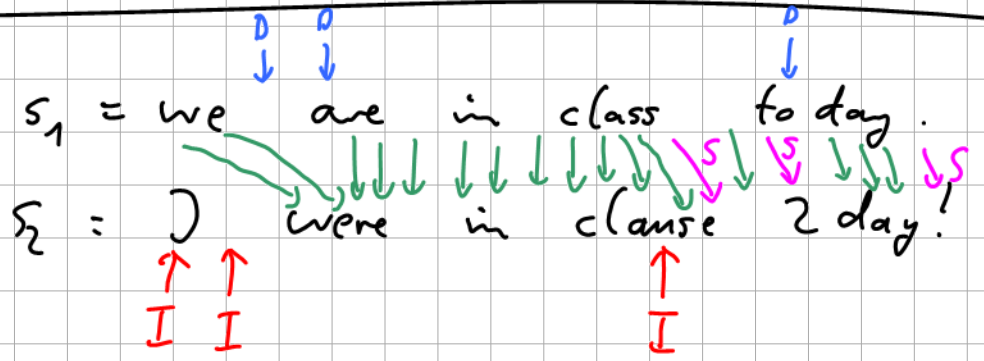
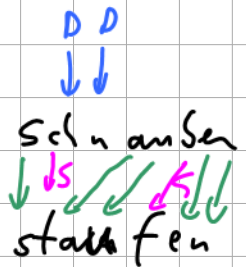
rough idea of the exam

1 Task	Python	10 Pt	
1 Task	chapter 2	10 Pt	
1 Task	chapter 3	10 Pt	→ each with subtasks
1 Task	chapter 4	10 Pt	→ in many cases subtasks can be solved independently
1 Task	surprise	10 Pt	

Levenshtein





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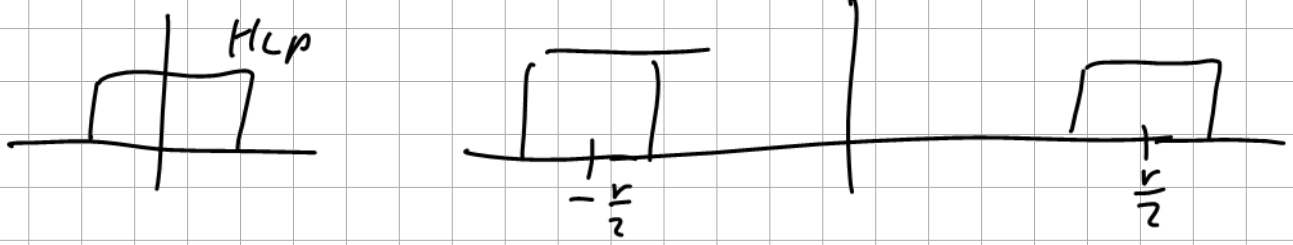
conversion LP → BP

$$h_{LP} \cdot \cos(2\pi f_m n/r) \quad \circ\!\!-\!\!\bullet \quad H_{LP} * \frac{1}{2}\left(\delta(f-f_m) + \delta(f+f_m)\right)$$

LP → HP



$$h_{LP} \cdot \cos\left(2\pi \frac{r}{2} \cdot \frac{n}{r}\right) = h_{LP} \cdot \cos(\pi n) = h_{LP} \cdot (-1)^n$$

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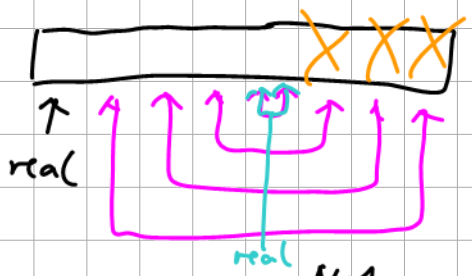
fft output

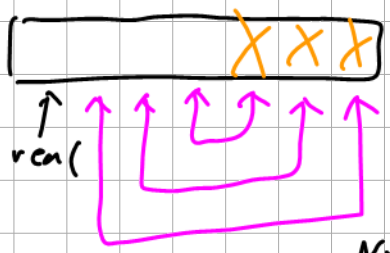
$K = 8$



$$X(k) = \sum_{n=0}^{N-1} x(n)\, e^{-j 2\pi \frac{nk}{K}}$$

2 real , $\frac{K}{2} - 1$ complex

$K = 7$



$$X(k=0) = \sum_{n=0}^{N-1} x(n)$$

1 real , $\frac{K-1}{2}$ complex