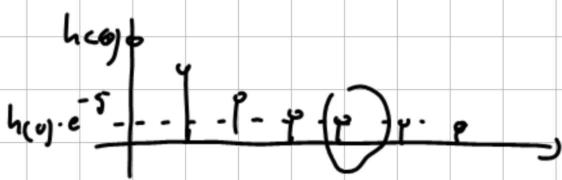
C2 J3 T4

$h(n) = (1-a)\, a^n$

$n_0 = ?$ $\quad h(n_0) \leq h(n=0) \cdot \underbrace{e^{-5}}$

fully loaded RC Lowpass
time for reaching stable behaviour



$$h(n_0) = h(n=0)\, e^{-5}$$

$$\cancel{(1-a)}\, a^{n_0} = \cancel{(1-a)}\, a^0\, e^{-5}$$

$$a^{n_0} = e^{-5}$$

$$n_0 = \log_a e^{-5}$$

$a = 0.7$: $\quad n_0 = \dfrac{\ln e^{-5}}{\ln a} = \dfrac{-5}{\ln 0.7} = \dfrac{-5}{-0.357} = 14.1$

$\Rightarrow n_0 = 15$

C4 J4 T2

$$y_j = \frac{e^{x_j}}{\sum_{i=0}^{I-1} e^{x_i}}$$

$$y_j = \frac{e^{x_j}}{e^{x_0} + e^{x_1} + e^{x_2}}$$

$$\left.\frac{dy_j}{dx_j}\right|_{j=0} = \frac{dy_0}{dx_0}$$

x_i				
0.5	→	SM	→	$\frac{1.65}{11.68} = 0.141$
2.3	→	SM	→	$\frac{9.97}{11.68} = 0.853$
−1.7	→	SM	→	$\frac{0.0601}{11.68} = 0.00522$

$e^{0.5} = 1.65$
$e^{2.3} = 9.97$
$e^{-1.7} = 0.0601$

$\Sigma\ 11.68$

$$y_0 = \frac{e^{x_0}}{e^{x_0} + e^{x_1} + e^{x_2}}$$

$$\frac{dy_0}{dx_0} = \frac{e^{x_0} \cdot (e^{x_0} + e^{x_1} + e^{x_2}) - e^{x_0} e^{x_0}}{(e^{x_0} + e^{x_1} + e^{x_2})^2}$$

$$= \frac{e^{x_0} \, \cancel{(e^{x_0} + e^{x_1} + e^{x_2})}}{(e^{x_0} + e^{x_1} + e^{x_2})^{\cancel{2}}} - \frac{e^{x_0}}{(e^{x_0} + e^{x_1} + e^{x_2})} \cdot \frac{e^{x_0}}{(e^{x_0} + e^{x_1} + e^{x_2})}$$

$$= y_0 - y_0 \cdot y_0$$

$$\frac{dy_0}{dx_1} = \frac{0 - e^{x_0} e^{x_1}}{(e^{x_0} + e^{x_1} + e^{x_2})^2}$$

$$= 0 - \frac{e^{x_0}}{e^{x_0} + e^{x_1} + e^{x_2}} \cdot \frac{e^{x_1}}{e^{x_0} + e^{x_1} + e^{x_2}}$$

$$= 0 - y_0 \cdot y_1$$

$$\frac{dy_j}{dx_i} = \begin{cases} y_j - y_j^2 , & \text{if } i = j \\ - y_j y_i , & \text{else} \end{cases}$$

C4 J4 I3

$$\frac{dL}{dx_i}$$

$$\boxed{L = - \sum_{j=0}^{J-1} \sigma_j \cdot \ln y_j \qquad \frac{dL}{dy_j} = - \sigma_j \frac{1}{y_j} \qquad y_j = \frac{e^{x_j}}{\sum_{i=0}^{I-1} e^{x_i}} \qquad \frac{dy_j}{dx_i} = \begin{cases} y_j - y_j^2 , & i = j \\ - y_j y_i , & \text{else} \end{cases}}$$

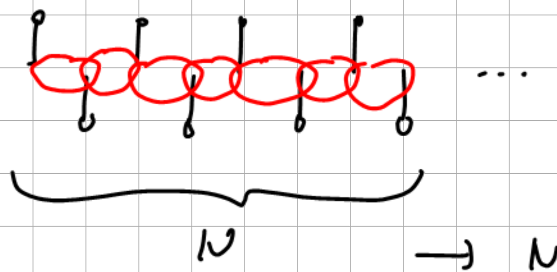
$$\frac{dL}{dx_i} = \frac{dL}{\cancel{dy_j}} \cdot \frac{\cancel{dy_j}}{dx_i} = \frac{dL}{dy_j} \cdot \frac{dy_j}{dx_i}$$

index j = ! $\Rightarrow$ replace missing indices by summations

$$\frac{dL}{dx_i} = \sum_{j=0}^{J-1} \frac{dL}{dy_j} \cdot \frac{dy_j}{dx_i}$$

$$= \begin{cases} \sum_{j=0}^{J-1} -\frac{\sigma_j}{y_j} \cdot (y_j - y_j^2) = \sum_{j=0}^{J-1} -\sigma_j (1 - y_j) & , \text{ for } i = j \\ \sum_{j=0}^{J-1} -\frac{\sigma_j}{y_j} \cdot (-y_j y_i) = \sum_{j=0}^{J-1} +\sigma_j y_i & , \text{ else} \end{cases}$$

C2 J7 T5



$\longrightarrow$ $N-1$ zero crossings

$$zcr = \frac{N-1}{N-1} = 1$$

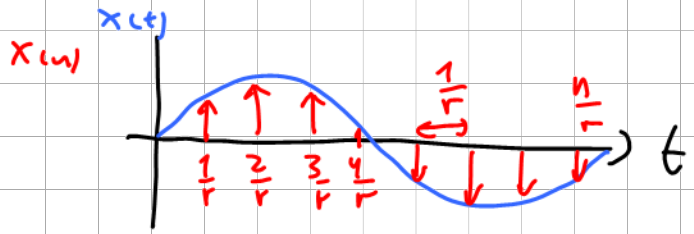
Exam: new SPO
5 Tasks
1 Task (= 10 Points)
for each chapter
1 Task surprise

old SPO
4 Tasks
1 Task (= 10 Points)
for each chapter

C2 J8 T2

$$x(t) = \hat{x} \cdot \sin(2\pi f t)$$

$f = 440$ Hz
$\hat{x} = 1$
$r = 1$ kHz



$t \to \frac{n}{r}$

$$x[n] = \hat{x} \sin\left(2\pi f \frac{n}{r}\right)$$

$$x[0] = 0$$

$x[1] = 0.368$

$x[2] = -0.685$

time Domain $E_{x} = x^2[0] + x^2[1] + x^2[2] = \dots$

freq. Domain $E_{X} = \frac{1}{3}\left(|X[0]|^2 + |X[1]|^2 + |X[2]|^2\right) = E_{x}$

Symmetry of DFT: