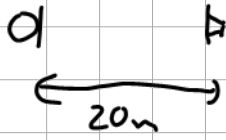


1) LTI - Linear Time Invariant

2)



$$T = \frac{20\text{m}}{343 \frac{\text{m}}{\text{s}}} = 58,3 \text{ ms}$$

3) The FIR Lowpass is symmetric around the maximum.

$$\Rightarrow \text{Delay is } \left\lfloor \frac{M}{2} \right\rfloor = 200 \text{ samples}$$

“rounding down brackets”

$$\Rightarrow T = \frac{200}{48000} \frac{1}{s} = 4,17 \text{ ns}$$

$$4) \text{ Delay} = \frac{\int_{-\infty}^{\infty} t \cdot |h(t)| dt}{\int_{-\infty}^{\infty} |h(t)| dt} = \frac{\int_{-\infty}^{\infty} t \cdot \varepsilon(t) \cdot \frac{1}{\tau} e^{-\frac{t}{\tau}} dt}{\int_{-\infty}^{\infty} \varepsilon(t) \cdot \frac{1}{\tau} e^{-\frac{t}{\tau}} dt}$$

$$= \frac{\int_0^{\infty} t e^{-\frac{t}{\tau}} dt}{\int_0^{\infty} e^{-\frac{t}{\tau}} dt}$$

$$= \frac{\left[e^{-\frac{t}{\tau}} \tau^2 \left(-\frac{t}{\tau} - 1 \right) \right]_0^{\infty}}{\left[-\tau e^{-\frac{t}{\tau}} \right]_0^{\infty}}$$

$$= \frac{0 - 1 \cdot \tau^2 (0 - 1)}{0 - (-\tau \cdot 1)}$$

$$= \tau //$$

From Bronstein: $\int x e^{ax} dx = \frac{e^{ax}}{a^2} (ax - 1)$

with $t \hat{=} x$ and $a \hat{=} -\frac{1}{\tau}$

5)

$$\text{Delay} = \frac{0 \cdot 1 + 1 \cdot 2 + 2 \cdot 4 + 3 \cdot 2 + 4 \cdot 1}{1 + 2 + 4 + 2 + 1} = \frac{20}{10} = 2$$









