$\boxed{A1}$

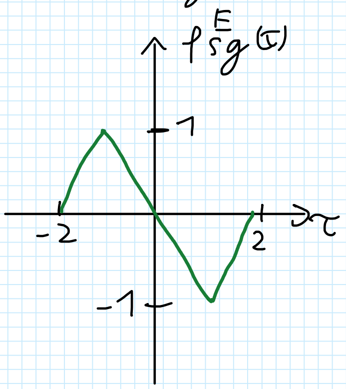
a) $\mathrm{rect}\left(\frac{t}{T}\right) * \mathrm{rect}\left(\frac{t}{T}\right) = T \cdot \Delta\left(\frac{t}{T}\right)$

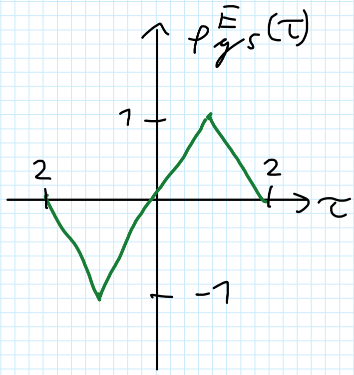
$T = 4 \qquad x(t) = \frac{1}{\sqrt{4}} \cdot \mathrm{rect}\left(\frac{t}{4}\right) = \frac{1}{2} \cdot \mathrm{rect}\left(\frac{t}{4}\right)$

or: $x(t) = \frac{1}{2} \cdot \mathrm{rect}\left(\frac{t-10}{4}\right)$ beliebig / arbitrary

b) $E_x = \varphi_{xx}^E(0) = 1$

c) $\varphi_{gs}^E(-\tau) = \varphi_{sg}^E(\tau)$





d) ja/yes $\quad \varphi_{sg}^E(0) = 0 \Rightarrow$ orthogonal

e) $\varphi_{sg}^E(\tau) = \Delta(\tau+1) - \Delta(\tau-1) \qquad \Delta(t) \circ\!\!-\!\!\bullet\, si^2(\pi f)$

$\circ\!\!-\!\!\bullet$

$\Phi_{sg}^E(f) = si^2(\pi f) \cdot \left[e^{j2\pi f} - e^{-j2\pi f}\right]$

$= si^2(\pi f) \cdot \left[\cos(2\pi f) + j \cdot \sin(2\pi f) - \cos(2\pi f) + j \cdot \sin(2\pi f)\right]$

$= si^2(\pi f) \cdot 2j \sin(2\pi f)$ = Imaginary-Part

$0 =$ Real Part

2

a) Auto Korrelation: $\varphi_{xx}^{E}(\tau) = \varphi_{xx}^{E}(-\tau)$

Kreuzkorrelation: $\varphi_{xy}^{E}(\tau) = \varphi_{yx}^{E}(-\tau)$
(Cross-Correlation)

b)

$\Delta(t) \circ\!\!-\!\!\bullet \; si^2(\pi f)$

$\varphi_{ss}^{E}(\tau) = \frac{1}{3}\Delta\left(\frac{\tau}{3}\right) \circ\!\!-\!\!\bullet \; si^2(\pi f \cdot 3)$

Ähnlichkeitssatz / Similarity Theorem $b = \frac{1}{3}$

c)

$E_s = \varphi_{ss}^{E}(0) = \frac{1}{3}$

d) $\phi_{hh}^{E}(f) = |H(f)|^2 = 1$

e) $\phi_{gg}^{E}(f) = \phi_{hh}^{E}(f) \cdot \phi_{ss}^{E}(f)$ "Wiener-Lee"

f) $\phi_{sg}^{E}(f) = S^*(f) \cdot G(f) = S^*(f) \cdot S(f) \cdot H(f) = |S(f)|^2 \cdot H(f)$

$H(f) = j \cdot (\varepsilon(f) - \varepsilon(-f))$

$\phi_{sg}^{E}(f) = si^2(3\pi f) \cdot j \cdot (\varepsilon(f) - \varepsilon(-f))$

Orthogonal?

$$\int_{-\infty}^{\infty} \phi_{sg}^{E}(f)\,df \overset{!}{=} 0 = \int_{-\infty}^{\infty} \underbrace{\underset{\text{gerade/even}}{|S(f)|^2} \cdot \underset{\text{ungerade/odd}}{H(f)}}\,df$$

symmetrisches Integral über ungerade Fkt. $= 0$
symmetrical integral over odd function $= 0$

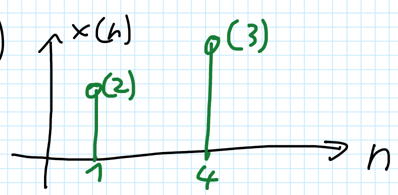
$\Rightarrow$ orthogonal

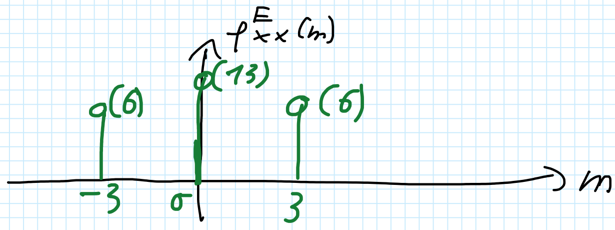
3

a) $x(n)$ ist kausal, da $x(n) = 0$ für $n < 0$

$x(n)$ is causal, because $x(n)=0$ for $n<0$

b)





$$\varphi^E_{xx}(m) = 6\cdot\delta(m-3) + 13\cdot\delta(m) + 6\cdot\delta(m+3)$$

c)

$$|X(f)|^2 = 6\cdot 2\cdot\cos(2\pi f\cdot 3\cdot 1) + 13$$
$$= 13 + 12\cdot\cos(6\pi f)$$

d)

$$E_x = 13 = \varphi^E_{xx}(0)$$

e)

$x(n)$ und $y(n)$ sind orthogonal, da sie sich im Zeitbereich nicht überlappen.

$x(n)$ and $y(n)$ are orthogonal, because they don't overlap in time-domain.

f)

$n_0 = 1 \Rightarrow$ Signale überlappen im Zeitbereich

signals overlap in time-domain

$\boxed{4}$

a)

$$\varphi^E_{sg}(\tau) = s(-\tau) * g(\tau)$$
$$= si(\pi\tau) * si(\pi\tau) * \delta(\tau-42)$$
$$= si(\pi\tau) * \delta(\tau-42) = si(\pi(\tau-42))$$

b)

$$E_y = \sum_{n=-\infty}^{\infty} y^2(n) = 1+9+1 = 11$$

c)

$$\varphi^E_{xy}(0) = \sum_{n=-\infty}^{\infty} x(n)\cdot y(n) = 1\cdot 1 + 3\cdot 1 + 1\cdot 1 = 5$$

d) $\varphi^E_{s_1 s_1}(\tau)$: ja / yes

- symmetrisch / symmetrical
- Maximum bei σ / maximum at σ

$\varphi^E_{s_2 s_2}(\tau)$: nein / no

unsymmetrisch wegen t^3 / unsymmetrical due to t^3

$\varphi^E_{s_3 s_3}(\tau)$: ja / yes

- symmetrisch / symmetrical
- Maximum bei σ / maximum at σ