Analog Haberleşme

ELEC 361 Midterm Exam (Fall 2023) çözümü

Orijinal not: Midterm-cozumu.pdf

UYARI Bu belge, el yazısı ders notlarından Claude (Anthropic) yardımıyla dijitale aktarılmıştır. Yardımcı kaynak olarak hazırlanmıştır; hata veya eksik içerebilir. Lütfen orijinal notları ve ders kaynaklarını esas alın.

NOTICE *This document was transcribed from handwritten lecture notes with the help of Claude (Anthropic). It is meant as a supplementary resource and may contain errors or omissions. Always check against the original notes and official course material.*

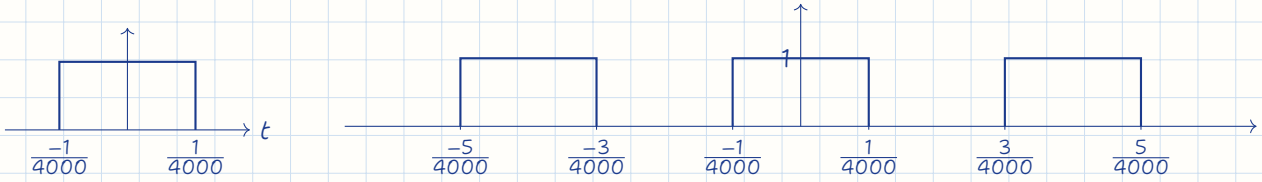
orj. s. 1

Şekil: Bu sayfa basılı materyal içeriyor (ör. ders slaytı); dijitalleştirilmedi.
(orijinal notta, s. 1)

$$x(t) = \sum_{k=-\infty}^{\infty} \Pi(2000t - 2k)$$

$$= \sum_{k=-\infty}^{\infty} \Pi\left(\frac{t - \frac{1}{1000}k}{1/2000}\right)$$

$$\Pi\left(\frac{t}{1/2000}\right) \Rightarrow$$



$$T_{\text{periyot}} = \frac{1}{1000} = \frac{4}{4000} = 10^{-3}\ \text{sn}, \qquad f_0 = 1\,\text{kHz}, \quad \omega_0 = 2000\pi$$

a)

$$x(t) = \sum_{n=-\infty}^{\infty} x_n e^{jn\omega_0 t}, \qquad x_0 = \frac{1}{T_0}\int x(t)\,dt$$

$$x_n = \frac{1}{T_0}\int x(t)\,e^{-jn\omega_0 t}\,dt$$

$$x_0 = 1000\int_{-1/4000}^{1/4000} 1\,dt = 1000 \cdot \frac{2}{4000} = \frac{1}{2}$$

$$x_n = \frac{1}{T_0}\int_{-1/4000}^{1/4000} 1\cdot e^{-jn2\pi \overset{1000}{f_0}\, t}\,dt$$

$$x_n = 10^3 \cdot \frac{-1}{jn2\pi 10^3}\left[e^{-jn2\pi\cdot 10^3\cdot\frac{1}{4}\cdot 10^{-3}} - e^{jn2\pi\cdot 10^3\cdot\frac{1}{4}\cdot 10^{-3}}\right]$$

$$= \frac{1}{\pi n}\cdot\frac{1}{2j}\left[e^{j\frac{n}{2}\pi} - e^{-j\frac{1}{2}n\pi}\right] = \frac{1}{\pi n}\sin\left(\frac{n\pi}{2}\right),\quad n\neq 0$$

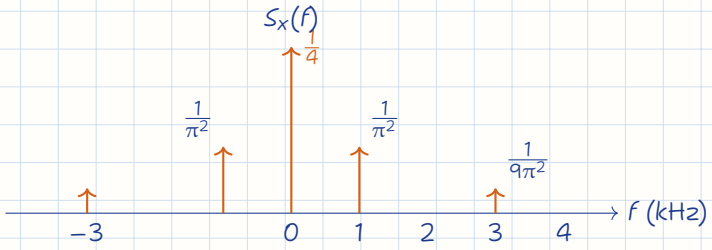
$$x(t) = \sum_{n=-\infty}^{\infty} x_n e^{jn2\pi f_0 t} = \frac{1}{2} + \sum_{\substack{n\neq 0\\ n\text{ tek}}} \frac{1}{\pi n}\underline{\sin\left(\frac{n\pi}{2}\right)}\, e^{jn2000\pi t}$$

$$\underline{\sin\left(\frac{n\pi}{2}\right)} \Rightarrow \begin{cases} 1, & n = 1,5,9,13 \\ -1, & n = 3,7,11 \end{cases}$$

$$S_x(f) = \sum_n |x_n|^2\,\delta(f - nf_0)$$

$$= \frac{1}{4}\delta(f) + \sum_{\substack{n\neq 0\\ n\text{ tek}}} \frac{1}{\pi^2 n^2}\,\delta(f - n1000)$$

orj. s. 2

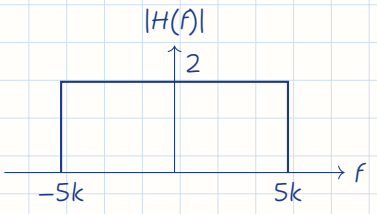


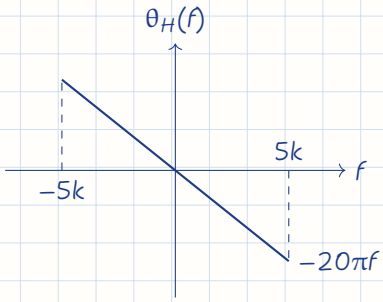
b) $x(t) \longrightarrow \boxed{h(t)} \longrightarrow y(t)$

$$h(t) = \underbrace{20000}_{A\tau}\,\text{sinc}(10k(t-10)), \qquad \tau = 10k,\quad A = 2$$

$$\Longleftrightarrow\quad H(f) = 2\,\Pi\left(\frac{f}{10k}\right)e^{-j2\pi f 10}$$

$$|H(f)| = 2\,\Pi\left(\frac{f}{10k}\right), \qquad \theta_H(f) = -2\pi 10 f$$

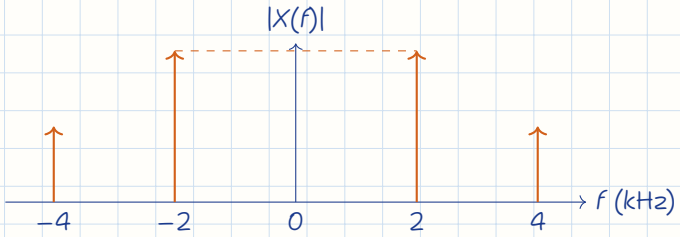




$\Rightarrow |H(f)|$, $x(t)$'nin spektrumunun tamamında $|k| \neq 0$ olmadığından bu işaret bozulmasız değildir.

c) $x(t) = 20\cos(2\pi\, 2k\, t) + 10\cos(2\pi\, 4k\, t)$

$$X(f) = 10\,[\delta(f-2k) + \delta(f+2k)]$$
$$+ 5\,[\delta(f-4k) + \delta(f+4k)]$$



$|H(f)|$, $X(f)$'in BG'si içinde sabit, $\theta_H(f)$'de lineer olduğu için sistem bu işaret için bozulmasızdır.

$k = 2, \quad t_d = 10$

$$x(t) \longrightarrow \boxed{h(t)} \longrightarrow y(t) = 2x(t-10)$$

$$S_y(f) = |H(f)|^2 \cdot S_x(f)$$
$$S_x(f) = 100\delta(f-2000) + 100\delta(f+2000) + 25\delta(f-4k) + 25\delta(f+4k)$$
$$S_y(f) = 400\delta(f-2k) + 400\delta(f+2k) + 100\delta(f-4k) + 100\delta(f+4k)$$

$$\mathcal{F}^{-1} \downarrow$$

$$\mathcal{R}_y(\tau) = 800\cos(2\pi\, 2k\,\tau) + 200\cos(2\pi\, 4k\,\tau)$$

1. yol: $P_y = \mathcal{R}_y(0) = 800 + 200$

2. yol: $P_y = \int_{-\infty}^{\infty} S_y(f)\,df = 2\cdot 400 + 2\cdot 100 = 1000$ W