6. KOMUNIKACIJSKI KANALI U KONTINUIRANOM VREMENU

(30) AKO JE POZNAT SPEKTAR SIGNALA $g(t)$, tj. $G(f)$, POTREBNO JE NAĆI AMPLITUDNI SPEKTAR SIGNALA $g_1(t) = g(t-t_0)$ ∀ t_0

• SPEKTAR SIGNALA:

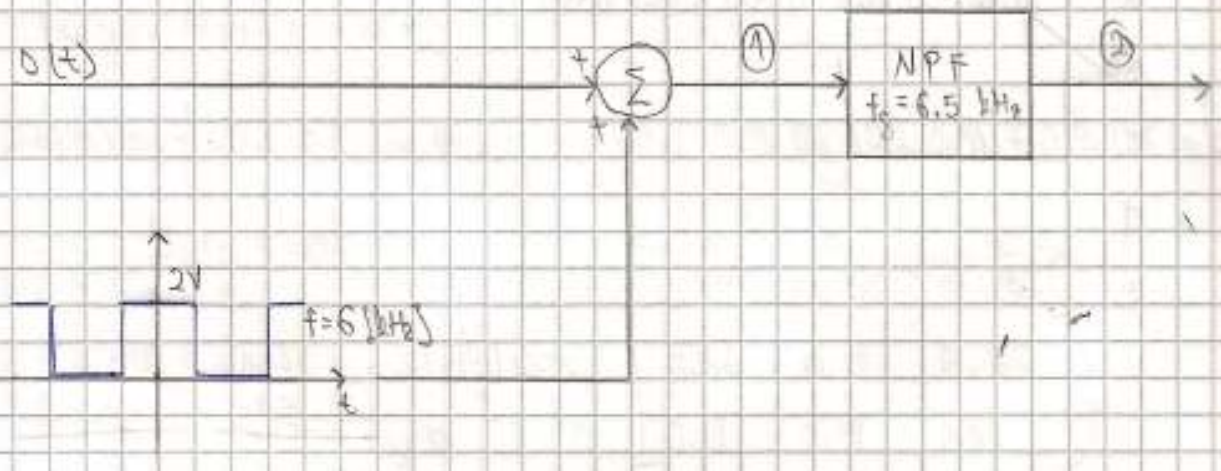
$$g(t) \rightarrow |G(f)|$$

$$g_1(t) = g(t-t_0) \rightarrow G_1(f) = G(f) \cdot e^{-j\omega_0 t}$$

$$\Downarrow$$

$$\boxed{|G_1(f)| = |G(f)|}$$

(31) ZA ZADANU SHEMU SA SLIKE, SKICIRAJTE SPEKTAR SIGNALA U TOČKAMA ① (DO 25 kHz) I ②, A ZATIM ODREDITE SREDNJU SNAGU SIGNALA NA IZLAZU IDEALNOG NISKO-PROPUSNOG FILTRA (NPF) GRANIČNE FREKVENCIJE $f_g = 6.5$ [kHz].



$$D(t) = 8\cos(14000\pi t) + 8\cos(2000\pi t)\ [V]$$

- VHODNI SIGNALI:

- SINUSNI:

$u_1(t) = 8\cos(140000\pi t) + 8\cos(8000\pi t)$ [V] $\Rightarrow \omega_0 = 2000\pi \Rightarrow f_0 = 1000$ [Hz]

- PRAVOKOTNI:

$$u_2(t) = A\frac{\tau}{T}\sum_{k=-\infty}^{\infty}\frac{\mathrm{Dim}\left(\frac{k\omega_0\tau}{2}\right)}{\frac{k\omega_0\tau}{2}} \quad ; \quad f_0 = 6000\ [\mathrm{Hz}]$$

$$; \quad \omega_0 = 12000\pi\ [\mathrm{Hz}]$$

$$u_2(t) = 4\cdot\frac{1}{2}\sum_{k=-\infty}^{\infty}\frac{\mathrm{Dim}\left(k\frac{\tau}{2}2\pi f_0\right)}{k\frac{\tau}{2}2\pi f_0}$$

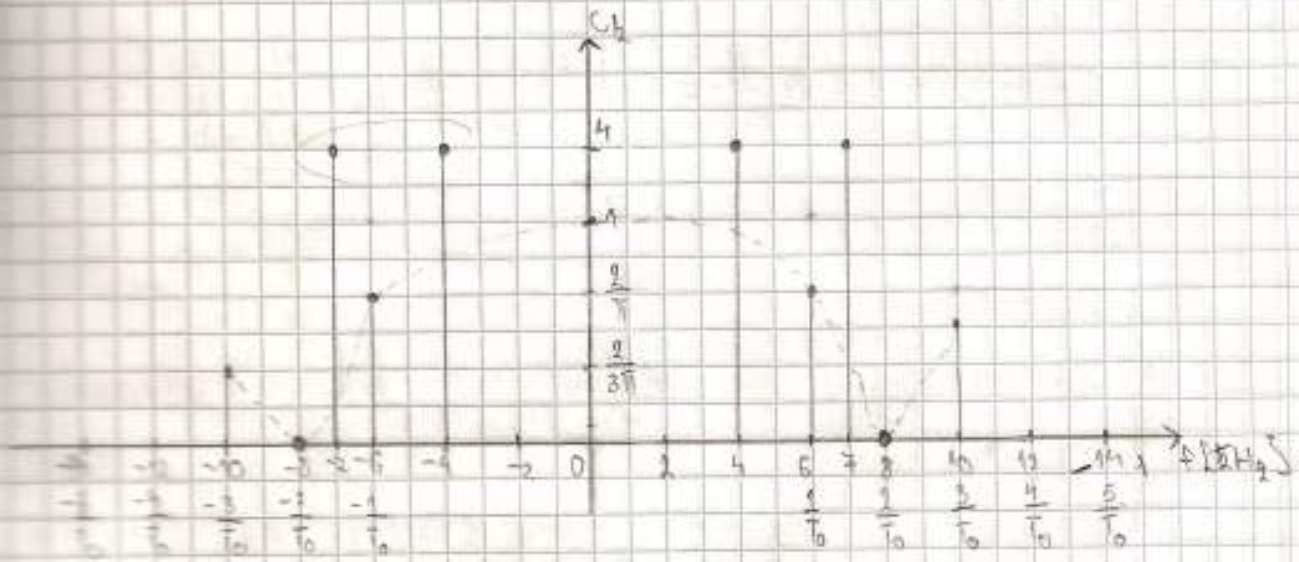
$$c_k = \frac{\mathrm{Dim}\left(k\frac{\tau}{2}\omega_0\right)}{k\frac{\tau}{2}\omega_0}$$

- SPEKTAR:

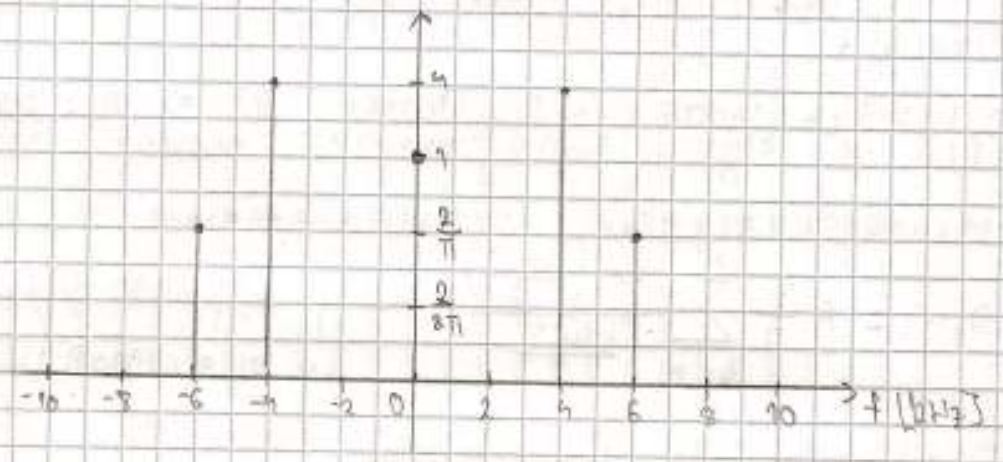
- SINUSNI: $c = \frac{A}{2} = \frac{8}{2} = 4$; $k = \pm 7$; $k = \pm 7$

- PRAVOKOTNI:

$$c_0 = 1 \ ; \ c_{\pm 1} = \frac{2}{\pi} \ ; \ c_{\pm 2} = 0 \ ; \ c_{\pm 3} = \frac{2}{3\pi}$$



* SPEKTAR SIGNALA NAKON FILTRA:



* SNAGA:

$$P = \sum c_k^2 = \left(\frac{2}{\pi}\right)^2 + \left(4\right)^2 + 1^2 + \left(4\right)^2 + \left(\frac{2}{\pi}\right)^2 = 33,81 \ [W]$$

8.

EA SIGNAL: $s(t) = 20\cos(2\pi t)$ [V] U ANALITIČKOM KOMUNIKACIJSKOM SUSTAVU DODJELJEN JE BIJELI ŠUM SPEKTRALNE GUSTOĆE SNAGE: $S_n(f) = e^{-3|f|}$ [W/Hz].

KORISNI SIGNAL SE DOVODI NA ULAZ FILTRA AMPLITUDNOG ODZIVA $|H(f)|$.

a) ODREDITE OMJER (S/N) NA IZLAZU FILTRA $\frac{V}{0}$

$s(t) = 20\cos(2\pi t)$ [V]

$S_n(f) = e^{-3|f|}$ [W/Hz]

$\left(\frac{S}{N}\right)_{IZLAZ} = ?$

- SNAGA SIGNALA:

$$P_S = \frac{A^2}{2} = \frac{20^2}{2} = 200 \text{ [W]}$$

- SNAGA ŠUMA:

$$P_N = \int_{-\infty}^{\infty} S_n(f)\,df = \int_{-\infty}^{0} e^{3t}\,dt + \int_{0}^{\infty} e^{-3t}\,dt = 2\int_{0}^{\infty} e^{-3t}\,dt =$$

$$= \begin{bmatrix} -3t = u \\ -3dt = du \\ dt = -\frac{1}{3}du \end{bmatrix} = -\frac{2}{3}\int_{0}^{-\infty} e^{-u}\,du = -\frac{2}{3}e^{-u}\Big|_{0}^{-\infty} = -\frac{2}{3} = \frac{2}{3}$$

- $\left(\frac{S}{N}\right)_{IZLAZ} = \frac{200}{\frac{2}{3}} = 300$

b) ODREDITE OMJER (S/N) U [dB], NA IZLAZU FILTRA AKO JE:

$H(f) = 1$ ZA $|f| < 2$ [Hz]

- SNAGA SIGNALA: $P_S = \frac{A^2}{2} = \frac{20^2}{2} = 200$ [W]

• SNAGA ŠUMA:

$$P_N = 1 \int_0^2 e^{-3t}\, dt = -\frac{2}{3} e^{-3t} \Big|_0^2 = \frac{2}{3}\left(1 - e^{-6}\right) =$$

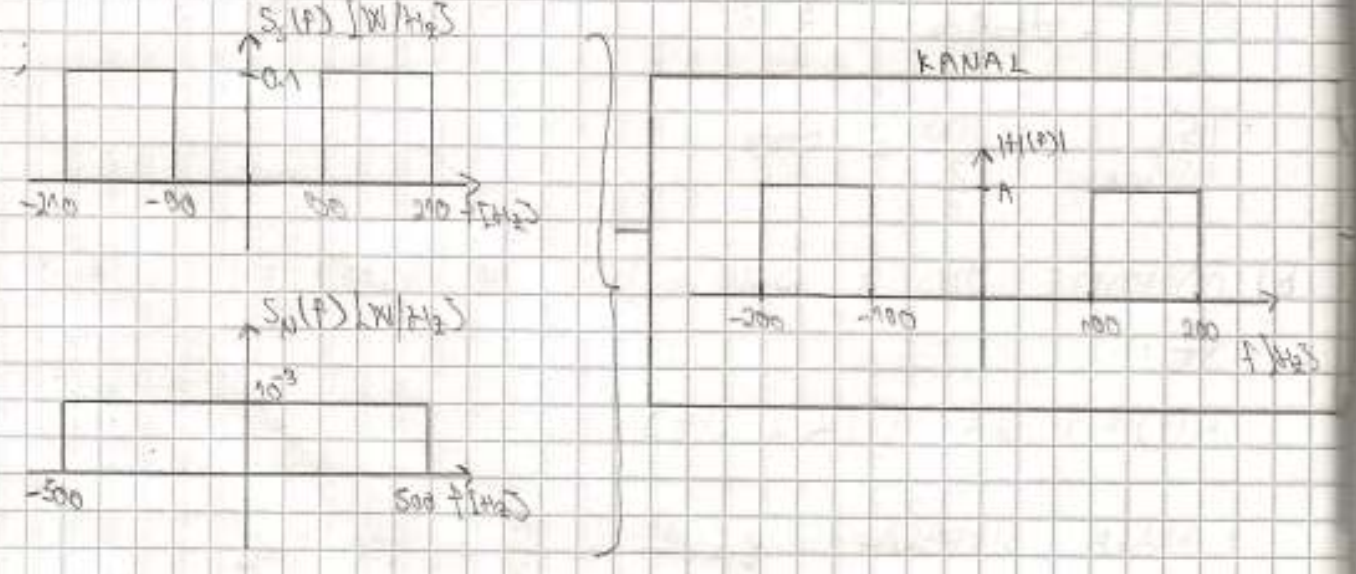
• OMJER:

$$\left(\frac{S}{N}\right)_{IZLAZ} = \frac{200}{\frac{2}{3}\left(1 - e^{6}\right)} = 300.75$$

$$\left(\frac{S}{N}\right)_{dB} = 10 \log_{10}\left(\frac{S}{N}\right) = 24.782\ [dB]$$

(33) NA ULAZ KANALA DOVODI SE SIGNAL SPEKTRALNE GUSTOĆE SNAGE $S_s(f)$.
NA SIGNAL DJELUJE POSAKNO OGRANIČENI BIJELI ŠUM, ČIJA JE SPEKTRALNA GUSTOĆA SNAGE $S_N(f)$.
ODREDITE ZA KOLIKO SE PROMIJENI OMJER (S/N) NA IZLAZU KANALA U ODNOSU NA NJEGOV ULAZ, tj. ODREDITE

$$\Delta\left(\frac{S}{N}\right) = \frac{\left(\frac{S}{N}\right)_{IZLAZ}}{\left(\frac{S}{N}\right)_{ULAZ}} = ?$$



• ULAZ:

• SNAGA SIGNALA:

$$P_S = 2\int_{t_a}^{t_b} A\,dt = 2\int_{90}^{210} 0{,}1\,dt = 0{,}2\,(210-90) = 24\ [W]$$

• SNAGA ŠUMA:

$$P_N = \int_{-500}^{500} 10^{-3}\,dt = 10^{-3}\,(500+500) = 1\ [W]$$

• OMJER: $\left(\frac{S}{N}\right)_{ULAZ} = \frac{24}{1} = 24$

• IZLAZ:

• SNAGA SIGNALA:

$$P_S = 2\int_{100}^{200} 0{,}1\,dt = 0{,}2\,(200-100) = 20\ [W]$$

• SNAGA ŠUMA:

$$P_N = 2\int_{100}^{200} 10^{-3}\,dt = 2\cdot 10^{-3}\,(200-100) = 0{,}2\ [W]$$

• OMJER: $\left(\frac{S}{N}\right)_{IZLAZ} = \frac{20}{0{,}2} = 100$

• OMJER (IZLAZ / ULAZ):

$$\Delta\left(\frac{S}{N}\right) = \frac{100}{24} = 4{,}167$$