

1. AUDITORNE

1. zadatost

32 kanala, svaki 64 kbit/s (8 kHz x 8 bita)
a) brzina prijenosa

$$a) R_b = n \cdot R_{bk} = 32 \cdot 6 = 2048 \text{ kbit/s}$$

$$b) T_b = \frac{1}{R_b} = 0,488 \mu\text{s}$$

c) sirina pojasa idealnog i Nyquistovog filtra

$$B_N = \frac{R_b}{2} = \frac{1}{2T_b} = 1024 \text{ MHz} \quad \text{idealni}$$

$$\text{realna sirina pojasa } B = B_N(1 + \alpha) = 1,43 \text{ MHz}$$

$$R_s \leq 2B$$

↓
sirina kanala

kada je = onda je to min sirina kanala

2. zadatost

sirina pojasa $B = 75 \text{ kHz}$

$$T_b = 10 \text{ ns}$$

$$\alpha = ? \quad (\text{faktor zaodysenja})$$

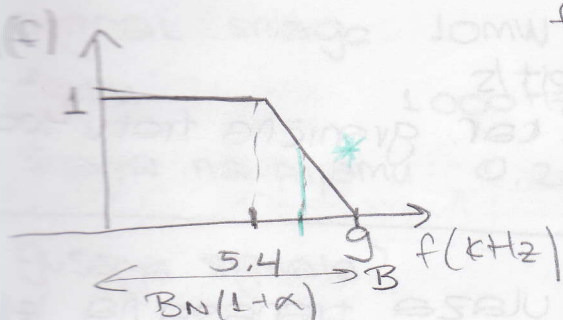
$$B_N = \frac{1}{2T_b} = 50 \text{ kHz}$$

$$B = B_N(1 + \alpha) \rightarrow \alpha = \frac{B}{B_N} - 1 = 0,5$$

↓
minimalna sirina Nyquistovog
pojasa

- zadatak

frecvencijska karakteristika



$$f_1 = 5,4 \text{ kHz}$$

$$f_2 = 9,0 \text{ kHz}$$

- a) max brzina prenosa da ne dođe do smetnji
 b) spektralna učinkovitost

a) $B = 9 \text{ kHz}$

$B_N = ?$ po II Nyquistovom teoremu B_N se nalazi na pola frekv. spektra *

$$B_N = \frac{f_1 + f_2}{2} = 7,2 \text{ kHz}$$

$$R_b = 2B_N = 14,4 \text{ kbit/s} \quad \text{max brzina prenosa}$$

b) $\frac{R_b}{B} = \frac{14,4}{9} = 1,6 \text{ kbit/s / Hz}$

sve je ovo u OSNOVNOM spektaru $\frac{1}{2} = \sigma T$

u području modulacija $R_b = \cancel{2} B_N \rightarrow R_b = B_N$

$$A = 10 \lg \left(\frac{20}{10} \right) = 3 \text{ dB}$$

$$5400 \text{ Hz} = 4$$

$$\frac{N}{\pi}$$

$$\left[\left(\frac{1}{2} \right)^s + 1 \right] \cdot \left(\frac{1}{\pi} \right)^s \cdot \left(\frac{1}{2} \right)^s = 9$$

$$1 - \frac{9}{5} \leq \frac{9}{5} \leq 10\% \quad \frac{9}{5} \leq 5\% \quad \frac{9}{5} = 10\% \quad \frac{9}{5} = 10\%$$

2. zadatku

signal snage 10mW
frekv. 1000 Hz

Snaga na prijemu 0,2mW

gusenje signala?

$$L = 10 \log \left(\frac{P_{ul}}{P_{pr}} \right) = 10 \log \left(\frac{10}{0,2} \right) = 17 \text{ dB}$$

P	A
$10x = \pm 10 \text{ dB}$	$10x = \pm 20 \text{ dB}$
$2x = \pm 3 \text{ dB}$	$2x = \pm 6 \text{ dB}$

7. zadatku

na ulazu signal snage 10mW

pojačalo snage iz 20mW

pojačanje?

$$A = 10 \log \left(\frac{20}{10} \right) = 3 \text{ dB}$$

$$C = B \log_2 \left(1 + \frac{S}{N} \right)$$

$$B = 5 \text{ MHz}$$

$$\frac{S}{N} = 12,6 \text{ dB} \Rightarrow \frac{S}{N} = 10^{\frac{12,6}{10}} = 18,2 \times$$

$$C = 5 \text{ MHz} \log_2 (1 + 18,2) = 21 \text{ MHz}$$

10. Zadatok

$$T = 290\text{K}$$

$$f = 10\text{MHz}$$

$$N = 10 \log K + 10 \log T + 10 \log B \quad (\text{dBW})$$

$$= -228,6 + 24,6 + 70$$

11. Zadatok

$B = 2,2\text{MHz}$ prenosni disk. bin. signal,

a) koliki je kapacitet kanala C ?

b) koliki je C , ako se prenos sa 16 diskretnih razina

$$a) C = R_{b\max} = 2B = 4,4\text{Mbit/s} \quad (\text{max kapacitet})$$

$$b) C = 2B \log_2 M = 8B = 17,6\text{Mbit/s}$$

12. Zadatok

između $2,2675\text{GHz}$ i $2,2725\text{GHz}$

$$S/N = 12,6\text{dB} \quad C = ?$$

$$C = B \log_2 \left(1 + \frac{S}{N} \right)$$

$$B = 5\text{MHz}$$

$$\frac{S}{N} = 12,6\text{dB} \rightarrow \frac{S}{N} = 10^{\frac{12,6}{10}} = 18,2\text{X}$$

$$C = 5\text{MHz} \log_2 (1 + 18,2) = 21\text{Mbit/s}$$

3. zadatak

kvantizacija sa 128 mogućih razina, 1 sni. bit
sirina pojasa $\downarrow 2\alpha+12$

$$\alpha = 1,0$$

a) brzina prijenosa kroz kom. kanal

$$n_q = 128$$

+ jedan sni. bit *

$$n_b = \log_2 n_q + 1 = 8 \text{ bit / uz}$$

$$B = B_N (1 + \alpha)$$

$$B_N = \frac{B}{1 + \alpha} = 6 \text{ kHz}$$

$$B_N = \frac{1}{2T_b}$$

$$B_N = \frac{1}{2T_s}$$

S broj simbola

$$T_s = 2B_N \rightarrow$$

$$B_N = \frac{1}{4T_b}$$

treba nam duploma
sirina pojasa

$$R_b = \frac{1}{T_b} = 4B_N = 24 \text{ Kbit/s}$$

b) frekv. uzoraka analognog sign, max frekv

$$\frac{R_b}{n_b} = \frac{24 \text{ Kbit/s}}{8} = 3 \text{ kHz}$$

$$f_{\max} = \frac{3}{2} = 1,5 \text{ kHz}$$

$$f_{\text{uz}} \geq 2B$$

$$B \leq \frac{f_{\text{uz}}}{2} \rightarrow \text{frekvencija uzorkovanja}$$

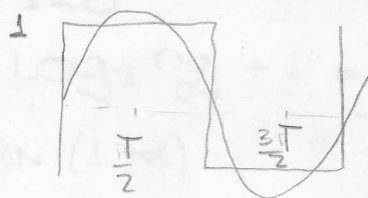
5. zadatku

binarni signal znakov 200kbit/s

kosinusno zaoobljenje frekv. kar. granične frekv. 400kHz

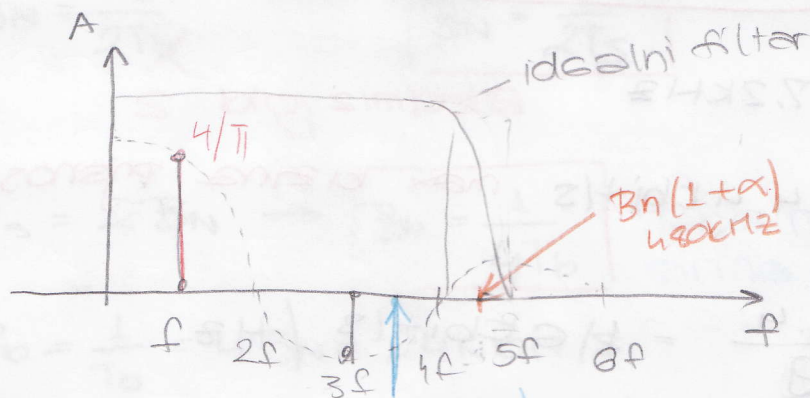
$$\alpha = 0,2$$

a) koliki se dio snage sa ulaza prenese na izlaz



Fourierov red izračunat
(od pravokutnog signala)

$$u(t) = \frac{4}{\pi} \sum_{n=1}^{\infty} (-1)^{n+1} \frac{1}{2n-1} \sin\left(\frac{2(2n-1)\pi t}{T}\right)$$



$$T_b = \frac{1}{R_b} = 5 \mu s$$

$$T = 2T_b = 10 \mu s$$

→ trajanje pravokutnog signala (period)

$$f = 100 \text{ kHz}$$

amplitude prvog harmonika $\frac{4}{\pi}$

$$\text{snaga: } P = \left(\frac{1}{2}\right) \left(\frac{4}{\pi}\right)^2 \left[1 + \left(\frac{1}{3}\right)^2\right]$$

kvadrat
amplitude

jer računamo s
polu spektra (zbog simetričnosti)

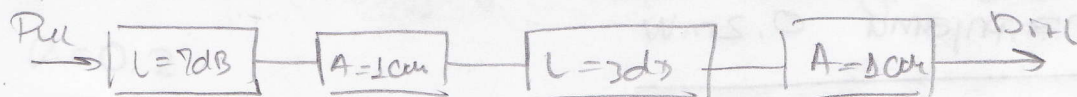
$$P_{uc} = 1$$

$$\eta = \frac{P}{P_{uc}} = 10\%$$

$$R_b \leq 2B_N \quad B_N \geq \frac{R_b}{2} = \frac{1}{T}$$

8. Zadatak

omjer ul i izl snage



$$P_{ul} - 7dB + 10dB - 3dB + 10dB = P_{izl}$$

$$10dB = 10 \log \left(\frac{P_{izl}}{P_{ul}} \right)$$

$$\frac{P_{izl}}{P_{ul}} = 10 \times$$

9. Zadatak

gustoca snage termickog sumana $T = 17^\circ C$

$$N_0 = k \cdot T$$

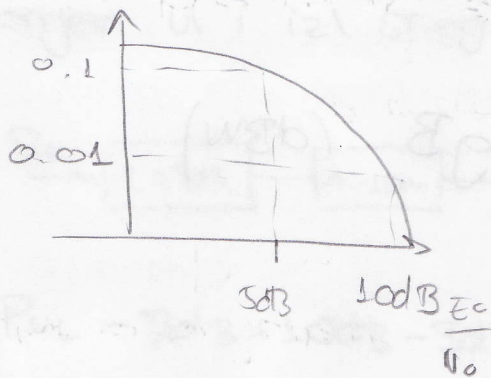
$$\downarrow$$

$$1.3803 \cdot 10^{-23}$$

$$N_0 = 1.3803 \cdot 10^{-23} \cdot 273,17 = 4 \cdot 10^{-21} \frac{W}{Hz}$$

$$N_0 = -204dB$$

13. zadatok



$$10 \log \frac{E_b}{N_0} = 5 \text{ dB} \quad \frac{E_{b1}}{E_b} = 3$$

$$E_{b1} = C T_{b1} = 3 E_b = 3 C T_b$$

$$T_{b1} = 3 T_b$$

$$R_{b1} = \frac{1}{T_{b1}} = \frac{1}{3 T_b} = \frac{R_b}{3} = 4800 \text{ bit/s}$$

14. zadatok

Diferenčnijsko kodiranje

izvor
 niz s duž. kod "1"
 1 0 1 1 0 0 0 1 0 0
 0 1 1 0 1 1 1 0 0 0
 0 0 1 1 1 0 1 0 0 1 0