

$R [t]$
 $N_{baud} [ks]$

$M = 2^{0,1} \Rightarrow m = 1$

} ce je $m=1$, uporabljamo 2 simbola, $R = N_{baud}$

Vaje:

1. Poisci pravno simbozi 4PSK signal preko pri hitri hitri 2000 bps. Prenos je half duplex (v eno ali drugo smer).

$M = 4$

$R = 2000 \text{ bps} = 2 \text{ kbps}$

| |
|------------------------|
| $R = m \cdot N_{baud}$ |
| $M = 2^m$ |
| $BW_k = N_{baud}$ |

$M = 4 \rightarrow m = 2$ ✓ dvočetno

$R = 2 \text{ kbps}$

$N_{baud} = \frac{R}{m} = 1 \text{ kbaud}$

)) ker je $m = 2$

$BW_k = 1 \text{ kHz}$

2. Podane je pasovna 5 kHz za 8-PSK. bitna in simbolna hitrost (N_{baud}) = ?

$m = 3$ (ker je 8 PSK ($2^3 = 8$))

$N_{baud} = 5 \text{ kbaud}$

$R = 5 \text{ kbps}$

8-PSK
 $BW_k = 5 \text{ kHz}$

$m = 3$

| |
|------------------------|
| $M = 2^m$ |
| $R = m \cdot N_{baud}$ |
| $BW_k = N_{baud}$ |

$BW_k = N_{baud} \Rightarrow N_{baud} = 5 \text{ kbaud}$ ✓

$R = m \cdot N_{baud} \Rightarrow 3 \cdot 5 \text{ kbaud} = \underline{15 \text{ kbps}}$

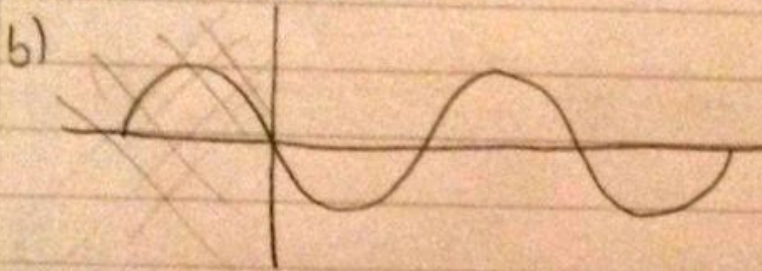
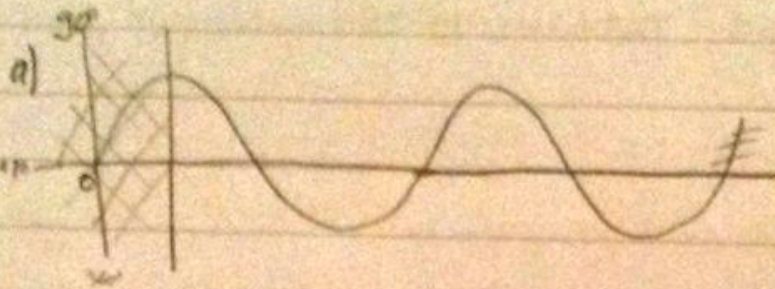
$N_{baud} = \frac{R}{m} \Rightarrow 5 = \frac{15}{3}$ ✓

VAJE · NALOGE

1. Nariši dve periodni sinusnega signala z naslednjimi:

a) 30°

b) 180°



2. Signal lahko razstavimo v 4 osnovne signale

$$A_1 = 3V$$

$$A_2 = 7V$$

$$A_3 = 5V$$

$$A_4 = 2V$$

$$f_1 = 10\text{Hz}$$

$$f_2 = 20\text{Hz}$$

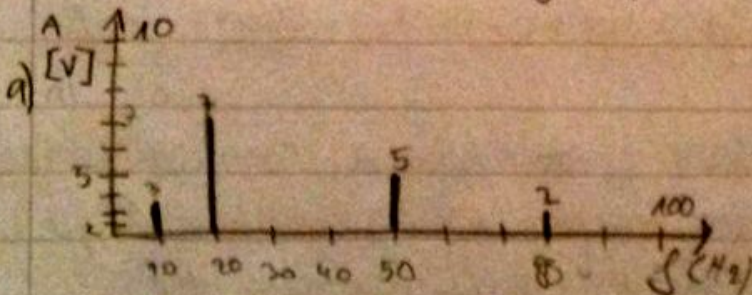
$$f_3 = 50\text{Hz}$$

$$f_4 = \del{20} 80\text{Hz}$$

a) spektralni diagram

b) izračunaj prenosovino

c) napiši enačbo tega signala ($x(t) = A_1 \cdot \sin(2\pi f_1 t)$)



• mi treba od časa - t začeti pisati

$$c) x(t) = 3 \cdot \sin(2\pi \cdot 10 \cdot t) + 7 \cdot \sin(2\pi \cdot 20 \cdot t) + 5 \cdot \sin(2\pi \cdot 50 \cdot t) + 2 \cdot \sin(2\pi \cdot 80 \cdot t) =$$

b) BW = ?

$$BW = f_n - f_1 \Rightarrow 80 - 10 = \underline{70\text{Hz}}$$

$$\left[3 \sin(20\pi t) + 7 \sin(40\pi t) + 5 \sin(100\pi t) + 2 \sin(160\pi t) \right]$$

končna enačba

Vaje:

1. Periodični komp. signal s posrečno frekvenco 2 kHz je sestavljen iz dveh sinusnih signalov. → frekv. 100 Hz, amplituda 20V

Podajte — enačbo! $x(t)$

$$f_1 = 100 \text{ Hz}$$

$$A_1 = 20 \text{ V}$$

$$A_2 = 5 \text{ V}$$

$$\boxed{BW = f_2 - f_1} \rightarrow 2000 \text{ Hz} + 100 \text{ Hz} = \overset{2100}{\cancel{1900}} \text{ Hz} = f_2$$

$$\begin{aligned} x(t) &= ? \Rightarrow A_1 \cdot \sin(2\pi \cdot f_1 \cdot t + \phi_1) + A_2 \cdot \sin(2\pi \cdot f_2 \cdot t + \phi_2) = \\ &= 20 \cdot \sin(2\pi \cdot 100 \text{ Hz} \cdot t) + 5 \cdot \sin(2\pi \cdot \textcircled{f_2} \cdot t) = \\ &= 20 \sin(200\pi \cdot t) + 5 \sin(2\pi \cdot 2100 \cdot t) = \\ &= 20 \sin(200\pi \cdot t) + 5 \sin(4200\pi \cdot t) \end{aligned}$$

| | | |
|-------|-------|------------|
| mili | m | 10^{-3} |
| mikro | μ | 10^{-6} |
| nano | n | 10^{-9} |
| piko | p | 10^{-12} |

| | |
|------|-----------|
| kilo | 10^3 |
| mega | 10^6 |
| giga | 10^9 |
| tera | 10^{12} |

pretvor ba
pri naloga!

10^3 k/s
 10^6 M/s
 10^9 G/s
...

2. Za podane periode izračunaj frekvence signalov. f

a) $T = 5 \text{ s}$

$$T = \frac{1}{f} \rightarrow f = \frac{1}{T} = \frac{1}{5} = \underline{\underline{0,2 \text{ Hz}}}$$

b) $T = 40 \mu\text{s} = 40 \cdot 10^{-6}$

$$T = \frac{1}{f} \rightarrow f = \frac{1}{T} = \frac{1}{40 \cdot 10^{-6}} = \frac{1}{40} \cdot 10^6 = \frac{10^6}{40} = 0,025 \cdot 10^6 = 25 \cdot 10^3 = \underline{\underline{25 \text{ kHz}}}$$

c) $T = 25 \text{ ms} = 25 \cdot 10^{-3} \text{ s}$

$$f = \frac{1}{T} = \frac{1}{25 \cdot 10^{-3}} = \frac{1}{25} \cdot 10^3 = \frac{1000}{25} = \underline{\underline{40 \text{ Hz}}}$$

d) $T = 20 \text{ ns} = 20 \cdot 10^{-9} \text{ s}$

$$f = \frac{1}{T} = \frac{1}{20 \cdot 10^{-9}} = \frac{1}{20} \cdot 10^9 \text{ Hz} = 0,05 \cdot 10^9 \text{ Hz} = 50 \cdot 10^6 \text{ Hz} = \underline{\underline{50 \text{ MHz}}}$$

EMOTE:

| <u>s</u> | <u>Hz</u> |
|-------------------|-------------------|
| ms ... 10^{-3} | kHz ... 10^3 |
| μs ... 10^{-6} | MHz ... 10^6 |
| ms ... 10^{-9} | GHz ... 10^9 |
| ps ... 10^{-12} | THz ... 10^{12} |

3. Za podane f , izračunaj vrednost signalov T

a) $f = 25 \text{ Hz}$

$T = ?$

$$T = \frac{1}{f}$$

$$T = \frac{1}{25} \text{ s} = 0,04 \text{ s} = 40 \text{ ms}$$

b) $f = 8 \text{ MHz} = 8 \cdot 10^6 \text{ Hz}$

$$T = \frac{1}{f} = \frac{1}{8 \cdot 10^6} = \frac{1}{8} \cdot 10^{-6} = 0,125 \cdot 10^{-6} = 0,125 \mu\text{s} = (0,125 \cdot 10^3) \cdot 10^{-9} = 125 \cdot 10^{-9} = 125 \text{ ns}$$

$$c) f = 200 \text{ Hz}$$

$$T = \frac{1}{f} = \frac{1}{200} = 0,005 \text{ s} = \underline{\underline{5 \text{ ms}}}$$

$$d) f = 125 \text{ kHz} = 125 \cdot 10^3 \text{ Hz}$$

$$T = \frac{1}{f} = \frac{1}{125 \cdot 10^3} = \frac{1}{125} \cdot 10^{-3} = 0,008 \cdot 10^{-3} = (0,008 \cdot 10^3) \cdot 10^{-6} =$$

$$= 8 \cdot 10^{-6} = 8 \mu\text{s}$$

$$e) f = 80 \text{ GHz} = 80 \cdot 10^9 \text{ Hz}$$

$$T = \frac{1}{f} = \frac{1}{80 \cdot 10^9} = \frac{1}{80} \cdot 10^{-9} = 0,0125 \cdot 10^{-9} = (12,5 \cdot 10^3) \cdot 10^{-12} =$$

$$= 12,5 \cdot 10^{-12} = \underline{\underline{12,5 \text{ ps}}}$$

4. Za podane bitne brzine izračunaj bitni interval. τ

$$a) R = 4 \text{ bps}$$

$$\tau = ?$$

$$\tau = \frac{1}{R} = \frac{1}{4} \text{ s} = \underline{\underline{0,25 \text{ s}}} = 250 \text{ ms}$$

$$b) R = 20 \text{ kbps} = 20 \cdot 10^3 \text{ bps}$$

$$\tau = \frac{1}{R} = \frac{1}{20 \cdot 10^3} \text{ s} = \frac{1}{20} \cdot 10^{-3} = 0,05 \cdot 10^{-3} = (0,05 \cdot 10^3) \cdot 10^{-6} =$$

$$= 50 \cdot 10^{-6} = \underline{\underline{50 \mu\text{s}}}$$

$$c) R = 10 \text{ Mbps} = 10 \cdot 10^6 \text{ bps}$$

$$\tau = \frac{1}{R} = \frac{1}{10 \cdot 10^6} = \frac{1}{10} \cdot 10^{-6} = 0,1 \cdot 10^{-6} = (0,1 \cdot 10^3) \cdot 10^{-9} =$$

$$= 100 \cdot 10^{-9} = \underline{\underline{100 \text{ ns}}}$$

5. Za podane bitne intervale izračunaj bitne brzine. R

$$a) \tau = 2 \text{ ms} = 2 \cdot 10^{-3} \text{ s}$$

$$R = \frac{1}{\tau} = \frac{1}{2 \cdot 10^{-3}} \text{ bps} = \frac{1}{2} \cdot 10^3 \text{ bps} = 0,5 \cdot 10^3 \text{ bps} = 0,5 \text{ kbps} = \underline{\underline{500 \text{ bps}}}$$

$$b) \tau = 25 \mu\text{s} = 25 \cdot 10^{-6} \text{ s}$$

$$R = 1/\tau = 1/25 \cdot 10^6 = \frac{1}{25} \cdot 10^6 = 0,04 \cdot 10^6 \text{ bps} = 40 \cdot 10^3 = \underline{\underline{40 \text{ kbps}}}$$

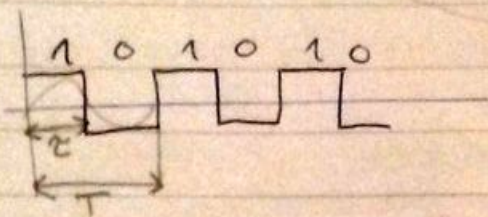
$$c) \tau = 0,4 \text{ ms} = 0,4 \cdot 10^{-3} \text{ s}$$

$$r = \frac{1}{\tau} = \frac{1}{0,4 \cdot 10^{-3}} = \frac{1}{0,4} \cdot 10^3 = 2,5 \cdot 10^3 \text{ bps} = \underline{\underline{2,5 \text{ Kbps}}}$$

6. Bitna hitrost signala je 8 kbps, amplituda je 10V. Namisi spekter z manj kot 10 zorcna 1010101010 a)

$$R = 8 \text{ kbps}$$

$$A = 10 \text{ V}$$



$$f_1 = \frac{1}{T} = \frac{1}{2\tau} = \frac{R}{2}$$

$$A =$$

$$f_2 = 3 \cdot f_1$$

$$f_3 = 5 \cdot f_1$$

$$f_4 = 7 \cdot f_1$$

$$A_2 = A/3$$

$$A_3 = A/5$$

$$A_4 = A/7$$

$$f_1 = \frac{8}{2} = 4 \text{ kHz}$$

$$f_2 = 3 \cdot 4 \text{ kHz} = 12 \text{ kHz}$$

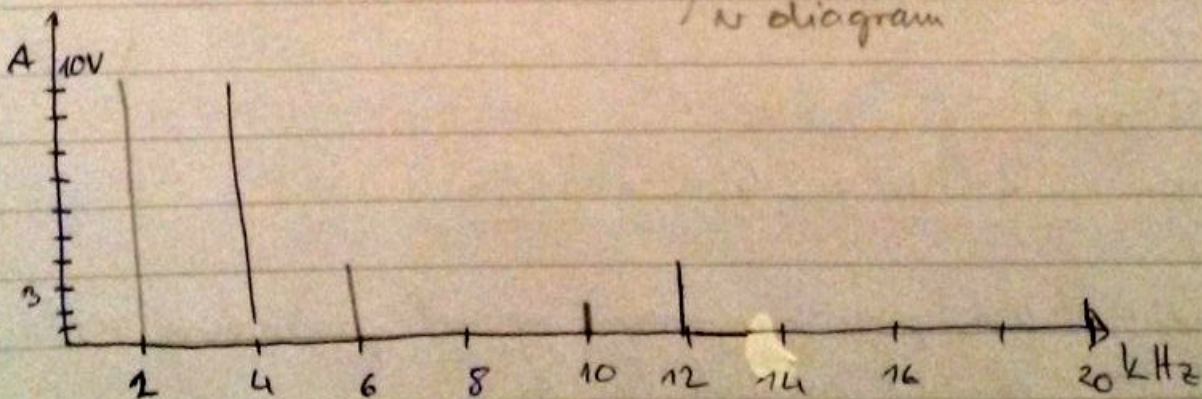
$$f_3 = 5 \cdot 4 \text{ kHz} = 20 \text{ kHz}$$

$$A_1 = 10 \text{ V}$$

$$A_2 = 10/3 = 3,3 \text{ V}$$

$$A_3 = 10/5 = 2 \text{ V}$$

izračunamo
in vnesemo
v diagram



b) 11 00 11 00 11

41 svinčnik

$$f = \frac{R}{2} = 2 \text{ kHz}, A = 10 \text{ V}$$

$$f_2 = 3 \cdot f_1 = 6 \text{ kHz}, A = 3,3 \text{ V}$$

$$f_3 = 5 \cdot f_1 = 10 \text{ kHz}, A = 2 \text{ V}$$

če tako piše, potem je
 $f_{min} = 0$

PK Vaje

1. Imamo govorni signal (pasovna širina 4 kHz) danih
pokrenim spekter za amplit. modula~~ci~~ signal, tj. Izračunaj
pas. šir. moduliranega signala

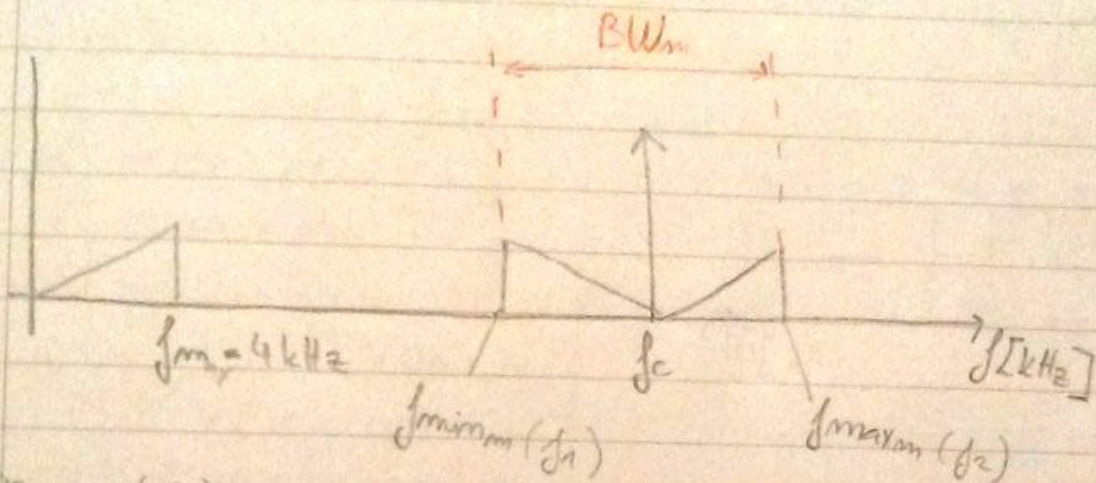
$$BW = 4 \text{ kHz}$$

AM

$$f_c = 150 \text{ kHz}$$

$$BW_m = ?$$

f nosilni signal
150 kHz



$$f_{min}^{(f_1)} = f_c - f_{max} = (150 - 4) \text{ kHz} = \underline{\underline{146 \text{ kHz}}}$$

$$f_{max}^{(f_2)} = f_c + f_{max} = (150 + 4) = \underline{\underline{154 \text{ kHz}}}$$

$$BW_m = f_2 - f_1 = 8 \text{ kHz}$$

ali

$$BW_m = 2 \cdot BW = 2 \cdot 4 \text{ kHz} = \underline{\underline{8 \text{ kHz}}}$$

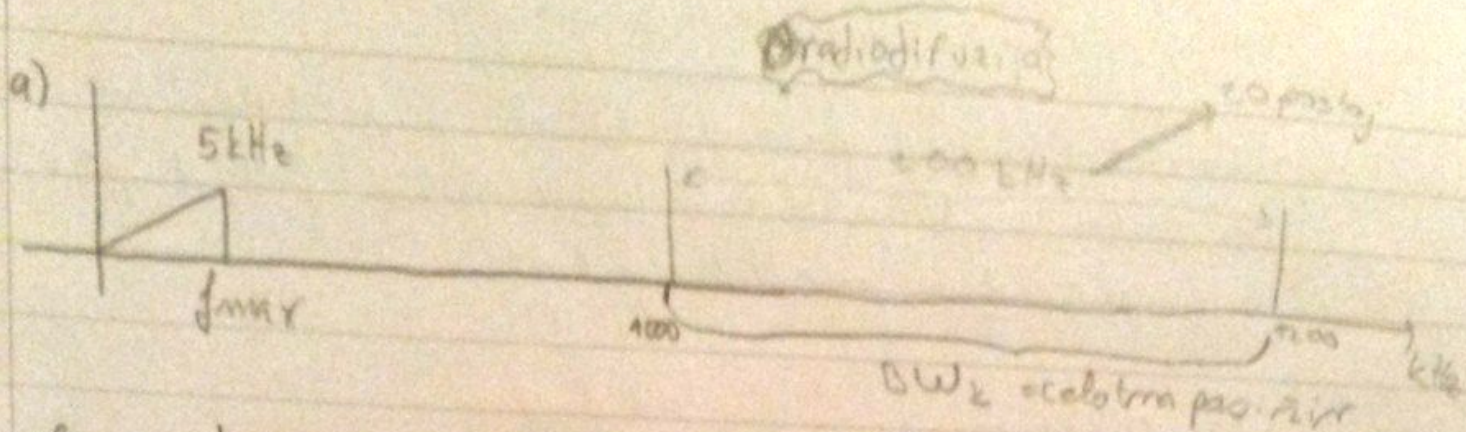
2. Radijska post. prenaša govorni signal pas. širine $BW = 5 \text{ kHz}$
postopkom amplit. modulacije A1

a) Koliko postaj lahko oddaja v pekov. pasu od 1000 kHz do 1200 kHz?

b) Kakšne so vrednosti nosilnih frekvenc za posamezne
postaje?

c) Koliko postaj lahko oddaja, če bi uporabljali varnostni
pas v n -v vrednosti 1 kHz?

d) Izračunaj vrednosti nosilnih pekov. za primer c).



ena postaja razreda 10 kHz \rightarrow koliko postaj pl "šmide"
 \rightarrow interval 1000-1200, ne manj 200 kHz

$$BW_m = 2 \cdot BW = 2 \cdot 5 \text{ kHz} = 10 \text{ kHz}$$

$$BW_k = 1200 \text{ kHz} - 1000 \text{ kHz} = 200 \text{ kHz}$$

\rightarrow št. postaj

$$E = \frac{BW_k}{BW_m} = \frac{200 \text{ kHz}}{10 \text{ kHz}} = \underline{\underline{20}}$$

obj.: odhaja lahko 20 postaj

b) - imamo 20 postaj \Leftrightarrow 20 nosilcev

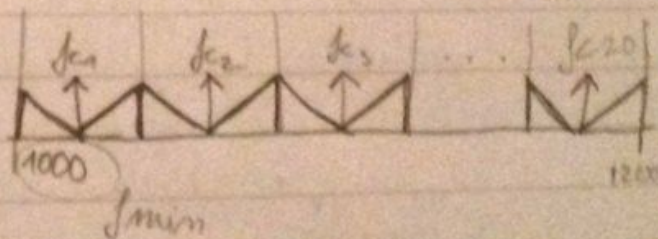
nosilne frekvence:

$$f_n =$$

$$f_{c1} + 2 \cdot BW = 1015$$

$$f_1 = f_{min} + BW = 1000 \text{ kHz} + 5 \text{ kHz} = 1005 \text{ kHz}$$

$$f_3 = f_2 + 2 \cdot BW = 1025 \text{ kHz}$$



c) $BW_v = 1 \text{ kHz} \rightarrow$ BW se poveča za 1, v katerem kanalu dobi

$$BW_m = 2 \cdot BW + BW_v = 10 \text{ kHz} + 1 \text{ kHz} = 11 \text{ kHz} \quad \left. \vphantom{BW_m} \right\} \text{koliko postaj?}$$

št. postaj

$$E = \frac{200}{11} = 18,18 = \underline{\underline{18}} \quad \text{obj.: odhaja lahko 18 postaj}$$

d)

$$f_{c1} = f_{min} + BW_m = \text{evrsko kot v prejšnjem primeru} = 1005 \text{ kHz}$$

$$f_{c2} = f_{c1} + BW_m = 1005 \text{ kHz} + 11 \text{ kHz} = 1016 \text{ kHz}$$

$$= 1027 \text{ kHz}$$

frekvencijski pas

3. Da valjo imamo prenosni kanal med frekvenco 1000 kHz in 1016 kHz, bi ga želelmo uporabiti za full duplex prenos z amplitudno modulacijo (AM).

$$f_1 = 1000 \text{ kHz}$$

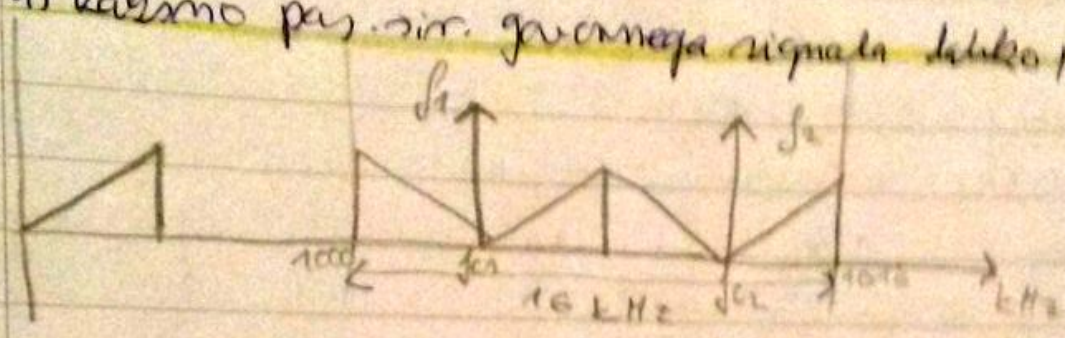
$$f_2 = 1016 \text{ kHz}$$

full-duplex



en kanal v eno smer, drug kanal v drugo smer

a) Kolikšno pas. sir. govornega signala lahko prenesemo?



$$BW = f_2 - f_1 = 1016 - 1000 = 16 \text{ kHz}$$

$$BW_G = \frac{BW}{4} = \frac{16}{4} = \underline{\underline{4 \text{ kHz}}}$$

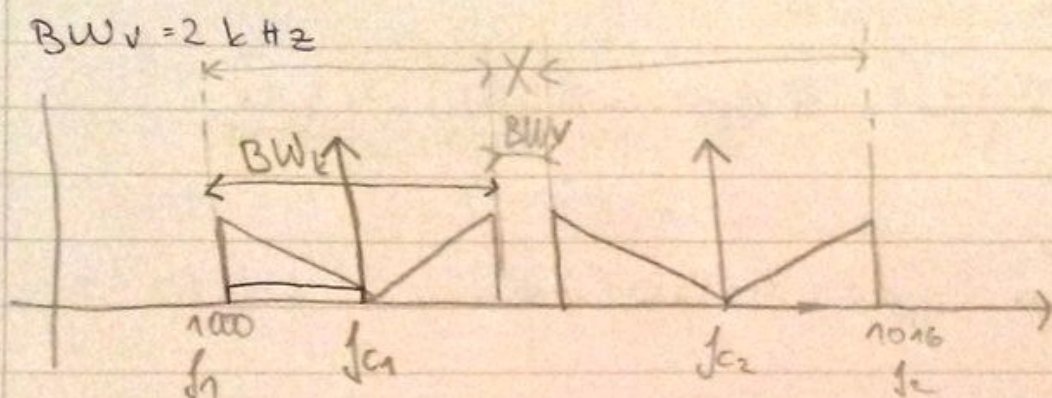
vrednosti obeh frekvenc:
 nosilnic

$$f_{c1} = f_1 + BW_G = 1000 \text{ kHz} + 4 \text{ kHz} = \underline{\underline{1004 \text{ kHz}}}$$

$$f_{c2} = f_2 - BW_G = (1016 - 4) \text{ kHz} = \underline{\underline{1012 \text{ kHz}}}$$

* half-duplex je dve smeri, ampak ne istočasno
 ↳ isto kot pri dvozmerni, kar je tisto BW
 ↳ zavezanec celotni pas, ter gre isto do različnih čiml

b) Kakšno pas. šir. gov. sig. lahko prenesemo, če uporabimo nosilni pas 2 kHz?



BW_k ... pasovna širina kanala

6 ... GOVORA

$$BW_k = \frac{BW - BW_v}{2} = \frac{16 - 2}{2} = \underline{\underline{7 \text{ kHz}}}$$

• odstopimo kar pas in potem delimo z dva, da dobimo širino ENEGA KANALA

$$BW_G = BW_k / 2 = 7 : 2 = \underline{\underline{3,5 \text{ kHz}}}$$

$$f_{c1} = f_1 + BW_G = 1000 \text{ kHz} + 3,5 \text{ kHz} = \underline{\underline{1003,5 \text{ kHz}}}$$

$$f_{c2} = f_2 - BW_G = 1016 \text{ kHz} - 3,5 \text{ kHz} = \underline{\underline{1012,5 \text{ kHz}}} \checkmark$$

$$= f_{c1} + 2BW_G + BW_v = 1003,5 + 2 \cdot 3,5 + 2 = 1003,5 + 7 + 2 = \underline{\underline{1012,5}} \checkmark$$

4 Za podane bitno hitrosti R in modulatorski postopek izračunaj potrebno pasovno širino medija (nariši tudi fazne diagrame!).

a) $R = 4 \text{ kbps}$, postopek: ASK

$$M = 2^m$$

$$R = m \cdot N_{\text{baud}}$$

$$BW_k = N_{\text{baud}}$$

a)

$$R = m \cdot N_{\text{baud}}$$

$$N_{\text{baud}} = \frac{R}{m}$$

$$N_{\text{baud}} = \frac{4 \text{ kbps}}{1} = 4 \text{ kbps} \Rightarrow BW_k = \underline{4 \text{ kHz}}$$

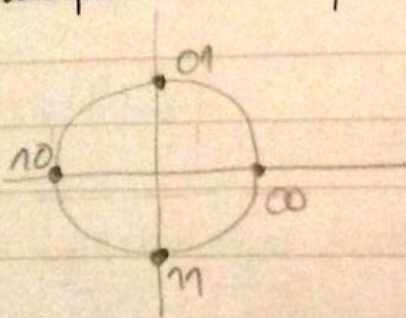
b) $R = 6 \text{ kbps}$, post.: 4-PSK (spreminjanje faze)

$$m = 2$$

$$R = m \cdot N_{\text{baud}} \rightarrow N_{\text{baud}} = \frac{R}{m} = \frac{6 \text{ kbps}}{2} = 3 \text{ kbps kbaud}$$

$$BW = \underline{3 \text{ kHz}}$$

* amplit. ne spreminja \Rightarrow kvadrantna



FAZNI DIAGRAM

c) $R = 6 \text{ kbps}$, postopek: 8-QAM

$$M = 8$$

$$8 = 2^m$$

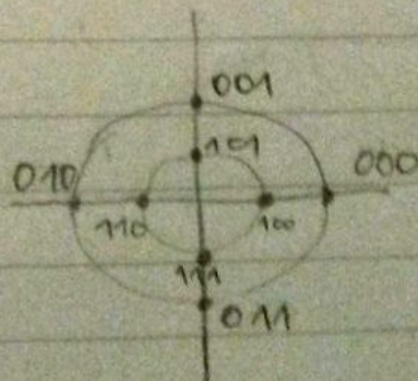
$$M = 2^m$$

$m = 3$ — rabimo 3 bite, da izrazimo, tj. 3 mesta

$$R = m \cdot N_{\text{baud}} \Rightarrow N_{\text{baud}} = \frac{R}{m} = \frac{6}{3} = 2 \text{ kbaud}$$

$$BW_k = \underline{2 \text{ kHz}}$$

FAZNI DIAGRAM



3 številke

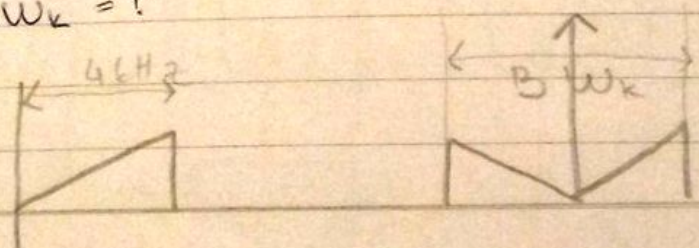
Kot na kolokviju

2. Prenajati želimo govorni signal pasovne širine 4 kHz. Pri digitalizaciji signala uporabimo 8 bitno kvantizacijo

a) Kakšna je pas. šir. signala pri amplitudni modulaciji?

$BW = 4 \text{ kHz}$
 $m = 8 \text{ bitov}$
 $BW_k = ?$

AM postopek



$BW_k = 2 BW = 2 \cdot 4 = 8 \text{ kHz}$

b) Kakšno pas. šir. medija potrebujemo za HDB3 prenos?

analogno-digitalna
dig prenos

an-dig

$BW_k = \frac{R}{2}$



$R = S \cdot n$
 $S = 2 \cdot f_{max}$

$R = 2 \cdot 4 \cdot 8 = 64 \text{ kbps}$

$BW_k = \frac{R}{2} = \frac{64 \text{ kbps}}{2} = 32 \text{ kHz}$

b.1) Če je metoda RZ (?) \rightarrow samo $BW_k = R \rightarrow 64 \text{ kHz}$

c) Kakšno pas-šir. medija ^{kanala} potrebujemo, če za prenos uporabimo 16-QAM modulator?

$$BW_k = ?$$

$$m = 4$$

$$(2^4 = 16)$$

$$M = 2^m$$

$$R = m \cdot N_{\text{baud}}$$

$$BW_k = N_{\text{baud}}$$

$R = 64 \text{ kbps}$ (iz b))

$$R = m \cdot N_{\text{baud}}$$

$$N_{\text{baud}} = \frac{R}{m} = \frac{64 \text{ kbps}}{4} = 16 \text{ kbaud}$$

$$\Rightarrow BW_k = \underline{\underline{16 \text{ kHz}}}$$

d) Kakšno preklapno modulacijo moramo uporabiti, da ~~je~~ zadostuje pas-šir. kanala, kot je izračunana pod a)?

$M = ?$ M -QAM

$$M = 2^m$$

$$BW_k = 8 \text{ kHz}$$

$$R = 64 \text{ kbps}$$

$$m = \frac{R}{N_{\text{baud}}} = \frac{64 \text{ kHz}}{8 \text{ kbaud}} = 8$$

$$M = 2^8 = \underline{\underline{256}} \Rightarrow 256\text{-QAM}$$

koliko delovi mreže b. m. t. m. p.

KONSTRUKCIJA H. KODE

PODAVO:

$r_1: 1, 3, 5, 7, 9, 11$

$r_2: 2, 3, 6, 7, 10, 11$

$r_4: 4, 5, 6, 7$

$r_8: 8, 9, 10, 11$

1. Konstruiraj hammingovo kodo

↓ m. p. do napisa

analogi
vertikalno →
moramo
družit
na zapo

| | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|--|----|----|----------------|---|----------------|---|---|---|---|----------------|---|
| | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| | 1 | 1 | 0 | 0 | X ¹ | 1 | 0 | 0 | 1 | 1 | 1 |
| | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | X ⁰ | 0 |
| | 1 | 1 | X ⁰ | 0 | 1 | 1 | 0 | 0 | 1 | X | X |

- a) ~~0110~~
- b) ~~0110~~
- c) 0101010
- d) 1101101

a) Če želimo poslati 7 bitni podatek 1101101 in
 zapisi pravilnih 7 bitov: **rešujemo podvršni mest:**

| R_8 | R_4 | R_2 | R_1 |
|-------|-------|-------|-------|
| 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 |

(R_1 **reparno št. enic** $\rightarrow 1$)

gledamo 2. vrstico, tisto, kar
 dolimo na prejemnika

\rightarrow kao da dobimo 6. eno

a) $8 \cdot 0 + 4 \cdot 1 + 2 \cdot 1 + 1 \cdot 1 = 7$ ^{mestu} na 7. bitu napaka, napravljen
 pravilnih 7 bitov (pari na ~~med.~~)

b) $8 \cdot 1 + 4 \cdot 1 + 2 \cdot 0 + 1 \cdot 0 = 12$ **UEKAJ NI DOBRO, tibe**
 =
 naloga ne bo!

če je napaka do 11, je OK (tabela 11 mest)

c) $0 \cdot 8 + 0 \cdot 4 + 1 \cdot 2 + 0 \cdot 1 = 2$ na 2. mestu je napaka

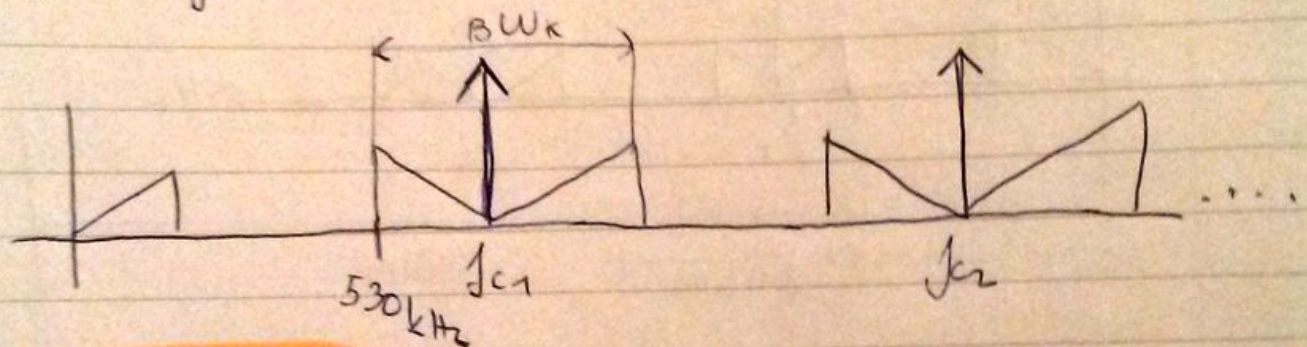
d) na 9. mestu $\Rightarrow 1 \cdot 8 + 0 \cdot 4 + 0 \cdot 2 + 1 \cdot 1 = 8 + 1 = 9$

MULTI PLEKSIONJE

2. Pri AM modulatoriji v srednjemvalnem področju ne uporabljaja fr. področje 530 kHz - 1700 kHz
Pas. šir. ~~2~~ audioprenosa je 5 kHz
signala

- Kakšno pas. šir. zasedi ena postaja? BW
- Kakšno je razdalja med nosilci? f_c
- Koliko postaj lahko oddaja v tem področju? E

na eni strani tvorimo več kanalov



a) $BW_k = 2 \cdot BW_m$

$BW = 5 \text{ kHz} \rightarrow BW_k = 2 \cdot 5 = \underline{\underline{10 \text{ kHz}}}$

2ač + BW

b) $530 + 5 = \underline{\underline{535 \text{ kHz}}}$: f_{c1}

$f_{c2} = 535 \text{ kHz} + 10 = \underline{\underline{545 \text{ kHz}}}$

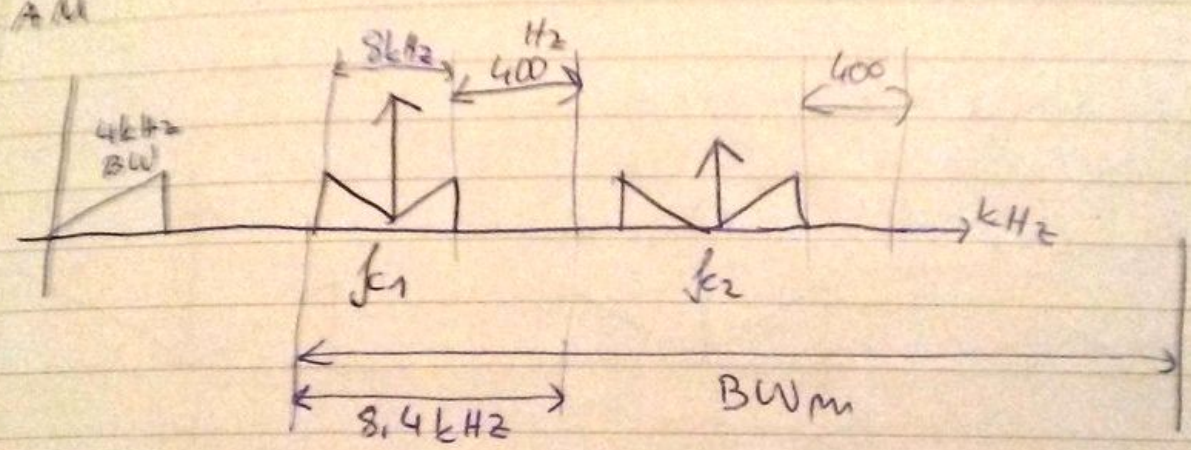
* mi namostnega pasu nunc

c) ~~širina~~ področja: $1700 - 530 = 1170$

$E = \frac{1700 - 530}{10} = \underline{\underline{117 \text{ kanali (postaj)}}$

3. Kolikino po sir. podeljenju 20 frekv. kanalov
 multiplexiranja, če imamo 8 evot in posiljeno
 signal s pramo širino 4 kHz 2 AM in imamo
 400 Hz varnostnega pasu?

FDM
 $E=8$
 $BW=4\text{ kHz}$
 AM



$$BW_k = 8\text{ kHz}$$

$$BW = E \cdot BW_k + (E-1) \cdot BW_v$$

$$BW = 8 \cdot 8\text{ kHz} + (7 \cdot 400\text{ Hz}) = 64\text{ kHz} + (2800\text{ Hz}) =$$

$$= 64\text{ kHz} + 2.8\text{ kHz} = \underline{\underline{66.8\text{ kHz}}}$$

1. Po prenosnem mediju želimo prenesti 25 kanalov za posil. digitaliziranega audio signala. Posil. audio signala je 15 kHz in ga digitaliziramo s 24 bit. Kakšno p. n. medija potrebujemo, ~~1111~~ ^{multiplizieren je}

a) če za posiljanje uporabimo 16-QAM prenosbo?

$E = 25$
 $BW = 15 \text{ kHz}$
 $m = 24 \text{ bit}$
 $BW_m = ?$

16-QAM
 $m = 4$

| | |
|--|---|
| $M = 2^m$ $R = N_{\text{band}} \cdot m$ $BW_k = N_{\text{band}}$ | $R = S \cdot m$ $S = 2 \cdot f_{\text{max}}$ |
|--|---|

$S = 2 \cdot 15 \text{ kHz} = 30$
 $R = 30 \text{ kHz} \cdot 24 = 720 \text{ kbit/s (kbps)}$
 $N_{\text{band}} = R/m = 720/4 = 180 \text{ kbaud}$
 $BW_k = 180 \text{ kHz}$
 $BW_m = 25 \cdot BW_k = 4500 \text{ kHz} = 4,5 \text{ MHz}$

b) Za posiljanje 24 bitovih znakov uporabimo Hemingo kodo in 128-QAM postopek. dada redundancne lute

$m = 24 \text{ bitov}$
 $E = 25 \text{ kanalov}$
 $BW = 15 \text{ kHz}$

QAM
 $m = 7$

$2^r \geq m + r + 1$
 $m = 24$
 $r = 5$

EVAEDMZA H. KODO

$2^r = m + r + 1$

3t. bitov znakov

$M_k = 29$
 $R_k = S \cdot M_k$

$2^5 \geq 24 + 5 + 1$
 $32 \geq 30$

$R = S \cdot m$
 $R = 30 \text{ kHz} \cdot 29 = 870 \text{ kbps}$

$N_{\text{band}} = \frac{R}{m} = \frac{870}{7} = 124,29 \text{ kbaud}$

$BW_k = 124,29 \text{ kHz}$

$BW_m = 25 \cdot 124,29 \text{ kHz} = 3107,25 \text{ kHz}$

b) $64 = 2^m$

$m = 6$

$R = 1,5 \text{ Gbps}$

$R = m \cdot N_{\text{band}}$

$1,5 \text{ Gbps} = 6 \cdot N_{\text{band}}$

~~$N_{\text{band}} = \frac{1,5 \text{ Gbps}}{6} = 250 \text{ Mbps}$~~

$R_k = \frac{R}{K_r} = \frac{1,5 \text{ Gbps}}{50} = 0,030 \text{ Gbps} = \underline{\underline{30 \text{ Mbps}}}$

~~$N_{\text{band}} = \frac{30 \text{ Mbps}}{6} = 5 \text{ Mband}$~~

$BW_k = N_{\text{band}} = \underline{\underline{5 \text{ MHz}}}$

KOLOKVIJ #2

- osnove prenosa do tega danes, do RADIODIFUZIJE
- 3 teoretska, 1 računsko

RADIODIFUZIJA (3. kolokvij)

- brezžično oddajanje

* Napisati bloke za imenikano časovno multipl. TDM 4avke

A JOŽE 1

B MARKO 2

C LEA 3

D MIHA 4

| | | | |
|---|---|---|---|
| M | L | K | J |
| I | E | A | O |
| H | A | R | Z |
| A | | K | E |

D B B A

A → 2 B → 3 C → 4 D → 1

| | | | |
|---|---|---|---|
| L | A | J | M |
| E | A | O | I |
| A | R | Z | H |
| | K | E | A |
| | O | | B |