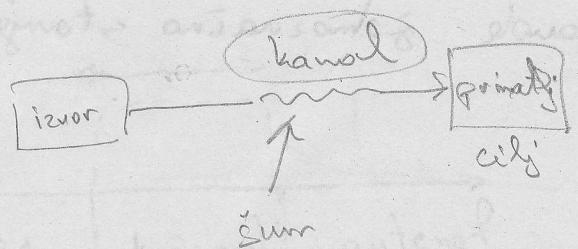


ELEKOM

1. masevne



dB

$$10 \log \left( \frac{P_1}{P_2} \right)$$

$$20 \log \left( \frac{u_1}{u_2} \right)$$

uredstevi

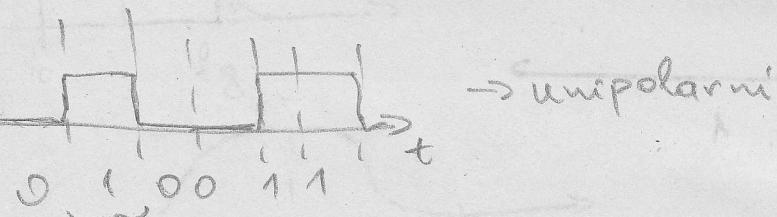
AIA telefon

DIA

AID

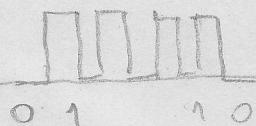
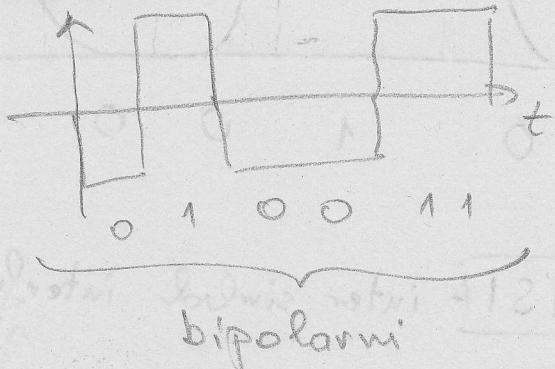
DID

Signali



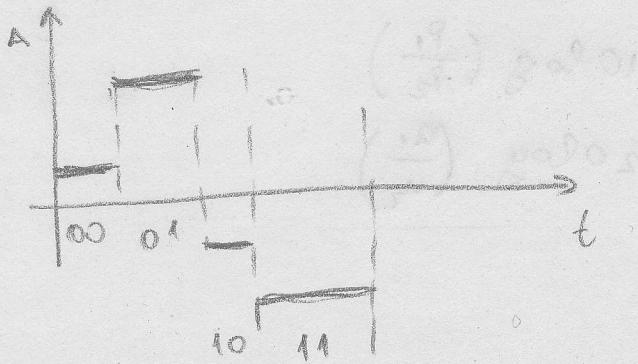
$T_b$  → trajanje bita

$$R_b \rightarrow \text{brzina traj. bita} = \frac{1}{T_b}$$

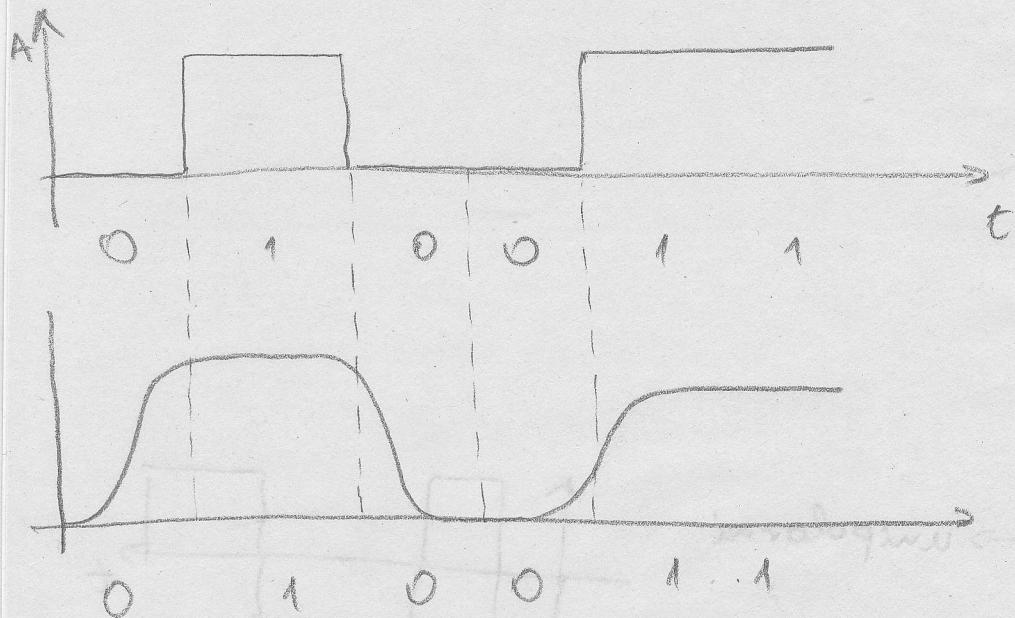


Y # < X

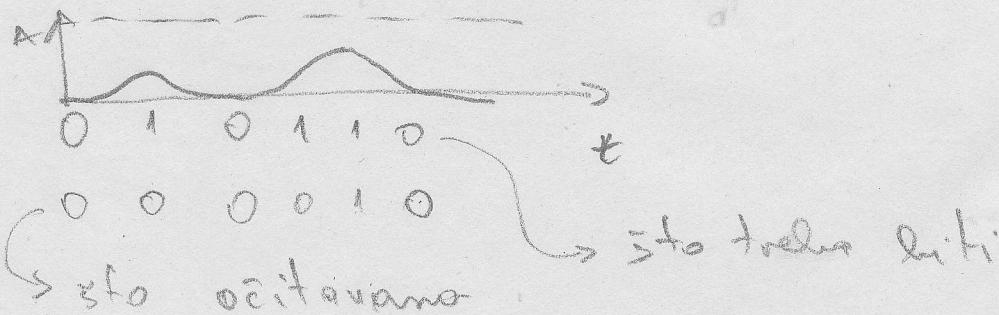
## Simboli



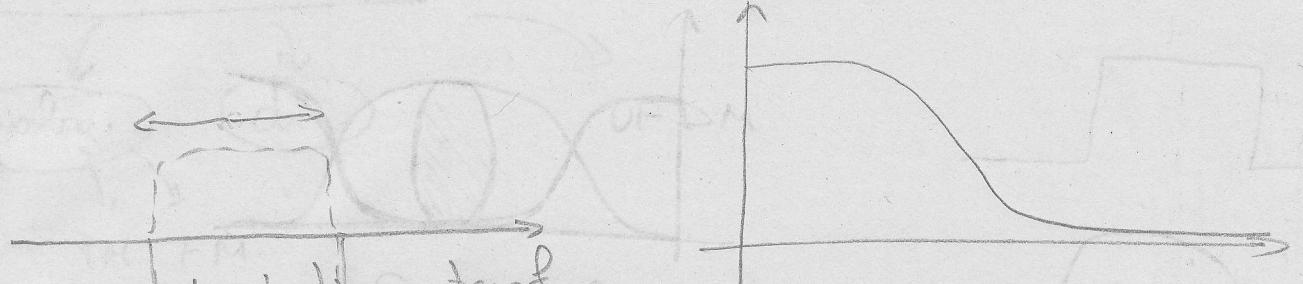
potreban broj bita da  
bude značajno stanje



**ISI** - inter simbol interferencija



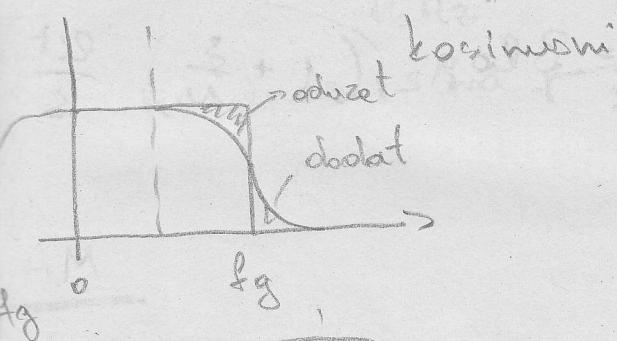
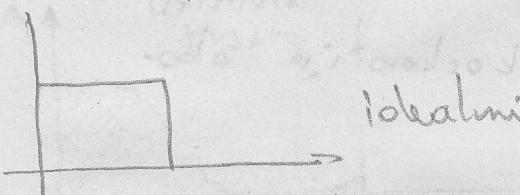
# frekvencijska slojena



HR 1  
krščanski radio

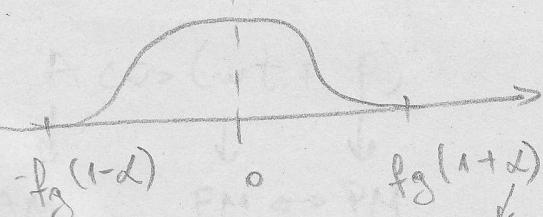
antena

Širina glasa  
zausima beskonačnu  
frekv.



uzeleno filter:  
odrezena ostatak

idealni međugaj



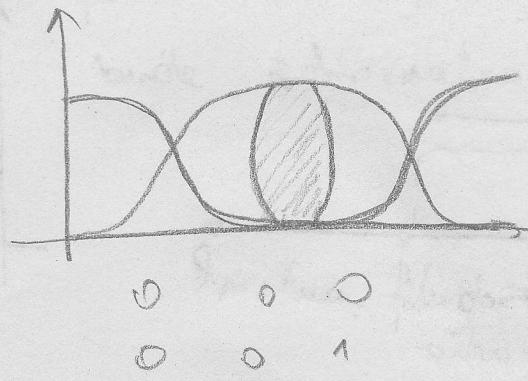
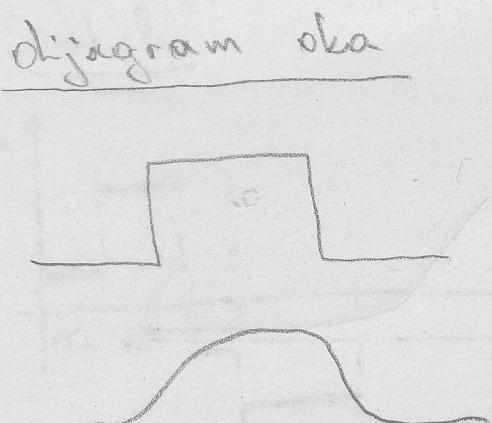
faktor razobljenja

$$\frac{S(bT)}{bT}$$

$$\left(\frac{S(bT)}{bT}\right) \text{ gal} \approx 1$$

$$\frac{f}{f_g} = k$$

modulirani signal je prenos informacija  
stigao u kanalu u obliku niza signal  
mobilnog telefona funkcija, ovde su



što je "kockasti" signal  
to je "kockasti" oko

Kapacitet [Hz]

$$C = 2B \log_2 M$$

[bit/s]

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

Prijenosni mediji

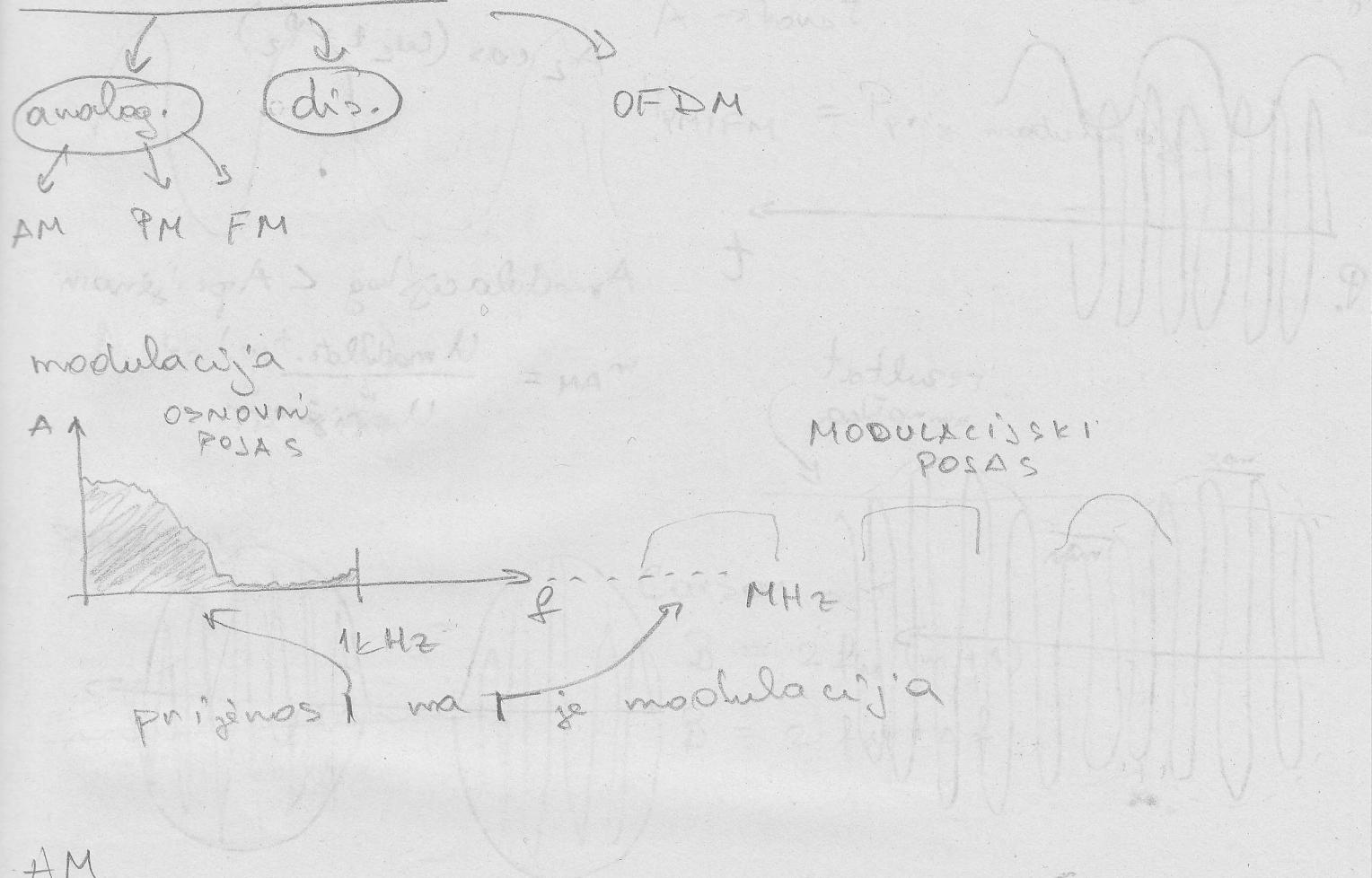
- zrak
- površina
- svjetloval -> snog brzi

$$L = 10 \log \left( \frac{n\pi d}{\lambda} \right)^2 \text{ [dB]}$$

$$L = \left( \frac{n\pi d}{\lambda} \right)^2$$

$$\chi = \frac{C}{f}$$

## 2. Modulacija

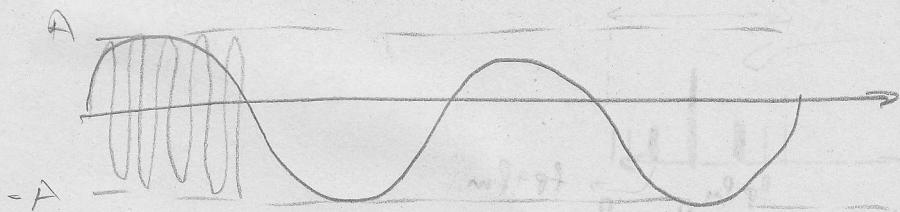


### AM

$$A \cos(\omega t + \phi)$$

↓      ↓      ↓  
AM      FM  $\leftrightarrow$  PM

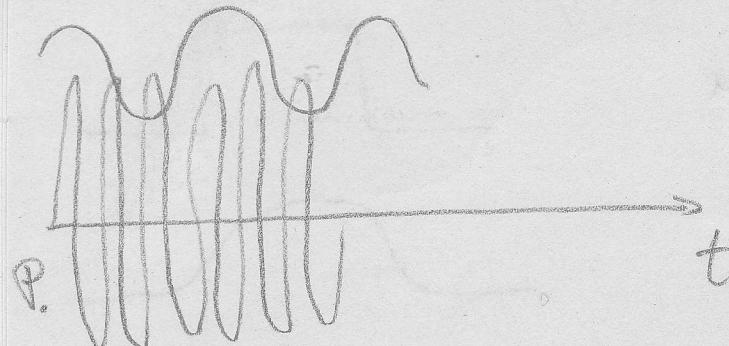
$$\omega = \frac{df}{dt}$$



modulacijski signal  $\rightarrow$  prenosi informaciju  
 prijenosni  $\rightarrow$  pomočni signal  
 modelirani  $\rightarrow$  zbroj / umnožak ovih dve je

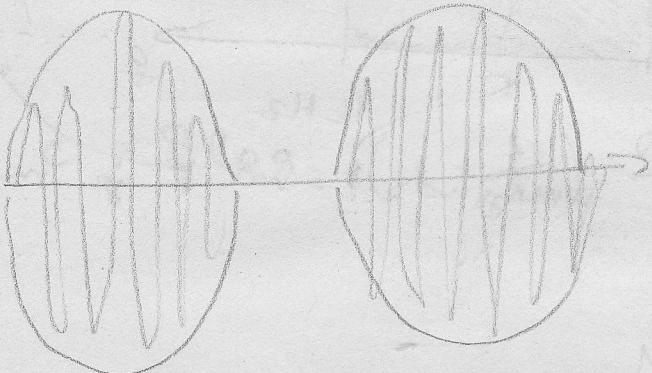
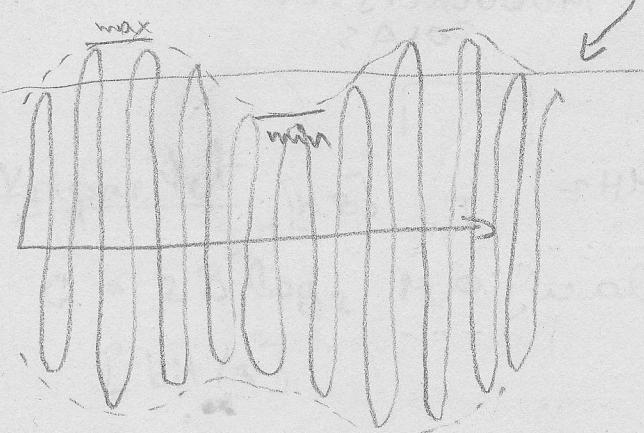
$f(\text{modulacyjki}) < f(\text{przenosni})$

$$A_2 \cos(\omega_2 t + \varphi_2)$$



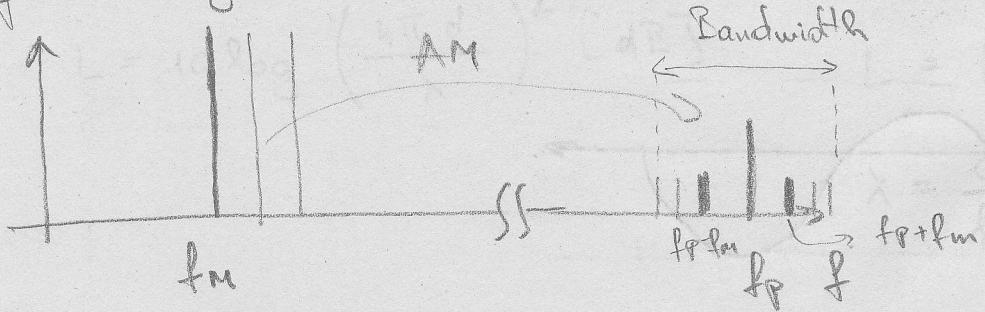
Amodulacyjny < A przenosu

$$m_{\text{AM}} = \frac{U_{\text{modulac.}}}{U_{\text{przenosu}}}$$



Premodulacja  
 $m > 1$

frekwenckowa dorosła



$$1 \cos f_p$$

$$2 \cos f_p + f_m$$

$$3 \cos f_p - f_m$$

PM



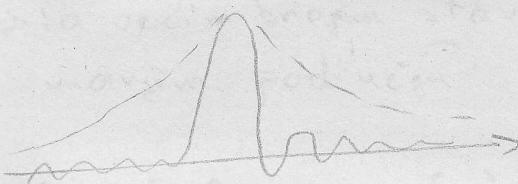
$A \rightarrow \text{konst}$

$$P_{PM/FM} = P_{\text{prije modulatie}}$$

$$A \cos(\omega t + \phi)$$

↓      ↓  
FM      PM

PM/FM:



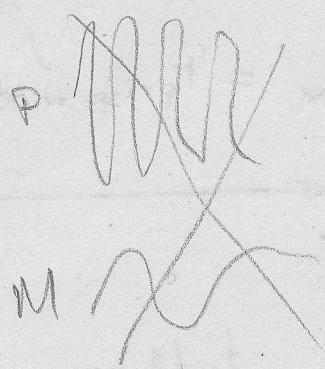
Carson ..

$$B = 2f_M(m+1)$$

$$B = 2f_M + \Delta f$$

### 3. Diskrete modulacije

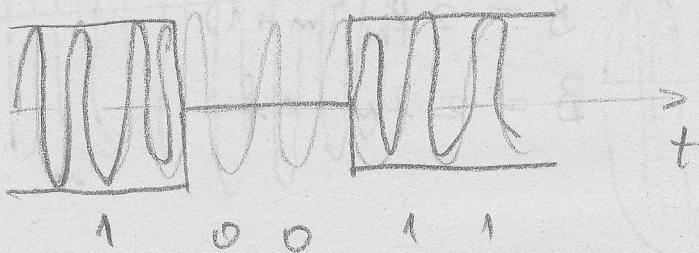
ASK  
PSK  
FSK  
---  
QAM  
MSK



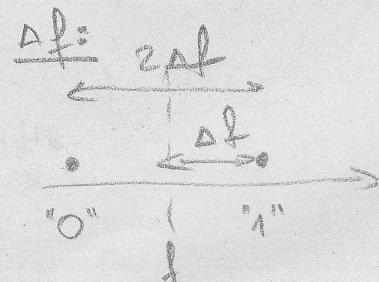
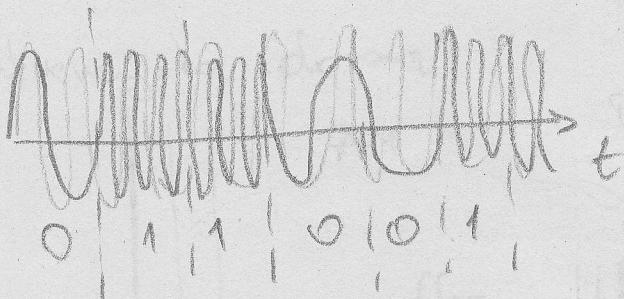
P:

M:

ASK:



FSK:



BFSK

4FSK

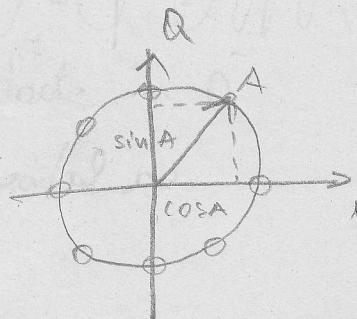
8FSK

PSK  $\rightarrow$  100% na ispitu?

BPSK

QPSK (4PSK)

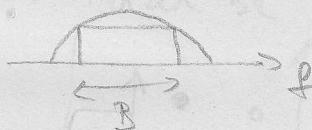
OQPSK



$$\begin{aligned} & \text{Acos}(\omega t + \phi) \\ & \text{konst} \quad \text{mjenje} \end{aligned}$$

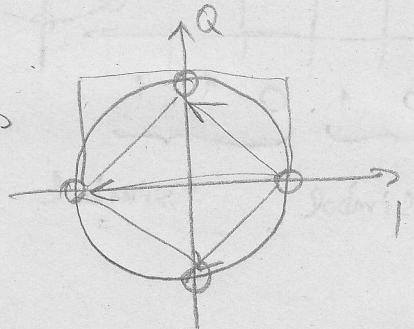
$\rightarrow$  sa većim brojem stanja prenosimo više informacija u manjem području

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



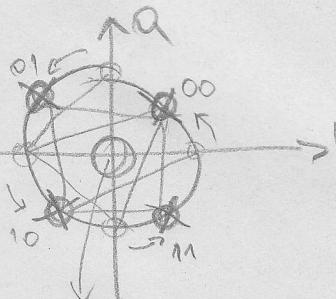
OQPSK

$\frac{\pi}{4}$ -QPSK

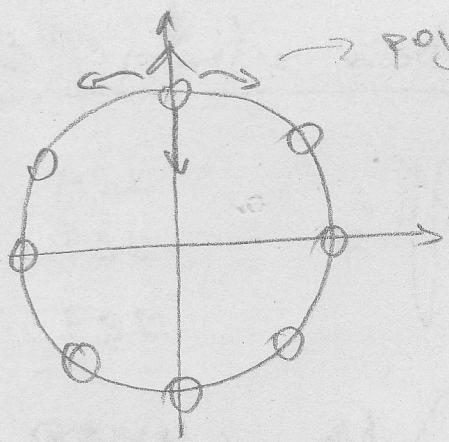


- lakše je napraviti sklop koji ne prolazi kroz 0
- time je napravljena OQPSK :  $\frac{\pi}{4}$ -QPSK

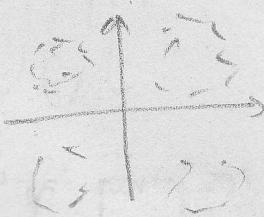
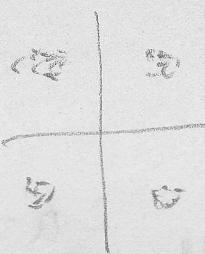
Li a farme pomaknuti:



ne prolazi  
kroz 0



pojavom sume miznja  
se polarizacija i amplituda



sa labosa → veća greška

$$R_b = \frac{1}{T_b} \quad [\text{bit/s}]$$

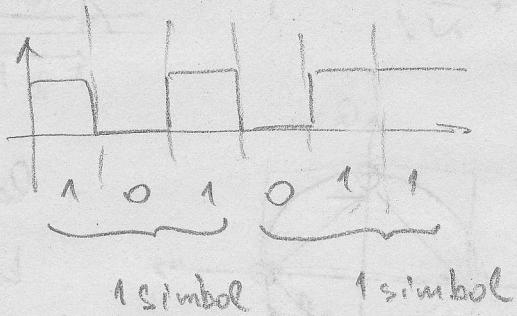
$$R_s = \frac{1}{T_s} \quad [\text{Bd}] \rightarrow [\text{symbol/s}]$$

$$R_b \leq R_s$$

$\downarrow$   
 $3 \rightarrow 8PSK$

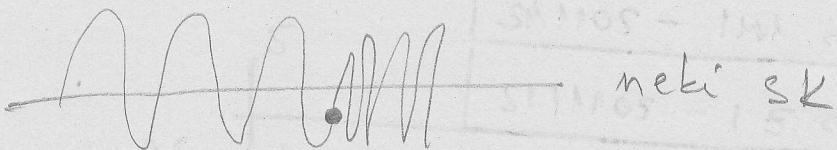
$$T_b \leq T_s$$

$\frac{1}{3} \rightarrow 8PSK$



MSK (minimum shift keying) mor - kod sklof

BFSK |  $m_f = 0,5$



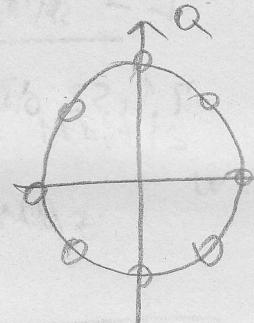
[8B] MSK

kvadrat doote u 0

$$\Delta f = \frac{\pi}{2}$$

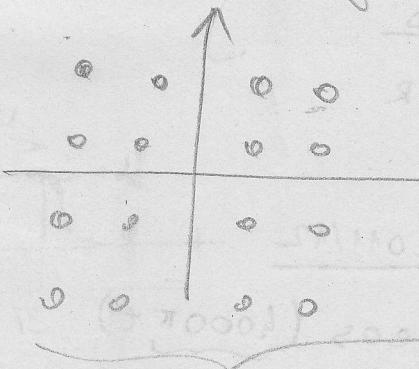
QAM: 1024 - QAM

8 - Pek



i Amplituda

i Faza se mijenja



16 - QAM

- manji utjecaj  
greske

# 11. Jes. Is-Rok - 2011/12

1. → 1.MI - 2011/12

3 → z1 - 2011/12

## ⑪ JIR - 2011/12

$$P = 100 \text{ W}$$

$$r = 100 \text{ m}$$

$$f = 1800 \text{ MHz}$$

$$P|_{r/2} = ?$$

$$L = 10 \log \left( \frac{4\pi d}{\lambda} \right)^2 \quad [\text{dB}]$$

$$= 20 \log \left( \frac{4\pi d}{\lambda} \right) \rightarrow \frac{r}{2} = 50 \text{ m}$$

$$P_{\text{dBW}} = 20 \text{ dBW} \rightarrow \frac{C}{f} = \frac{3 \cdot 10^8}{1,8 \cdot 10^9}$$

gúsenje:

$$L = 71,53 \text{ dB}$$

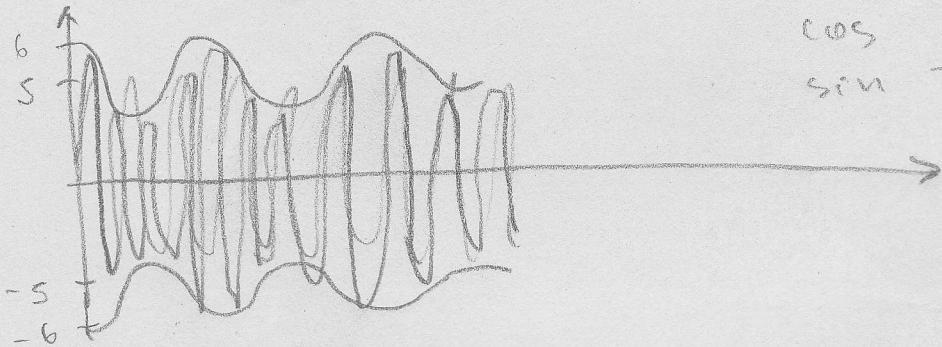
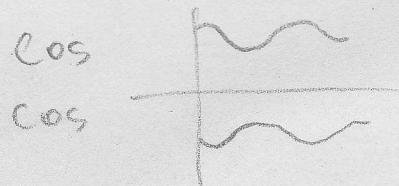
$$\left. \begin{array}{l} [\text{dB}] L = P_{\text{OD}} - P_{\text{PRimog}} \\ [\text{w}] L = \frac{P_{\text{OD}}}{P_{\text{PR}}} \end{array} \right\} \rightarrow P|_{\frac{r}{2}} = 20 \text{ dBW} - 71,53 \text{ dBW} = -51,53 \text{ dBW}$$

## ① 1.MI - 2011/12

$$U_p = 5 \cos(\underbrace{4000\pi t}_{\omega})$$

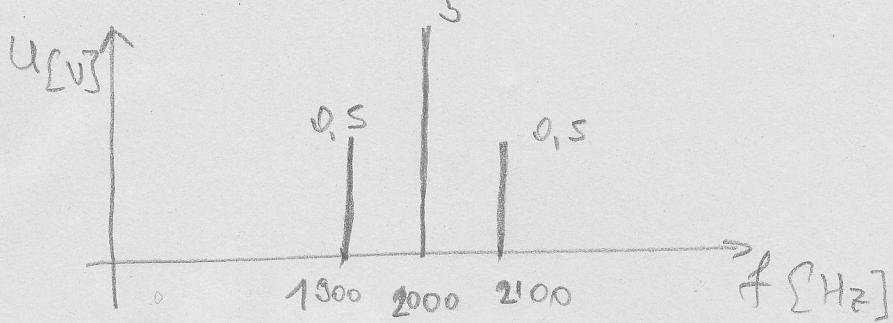
$$U_m = \cos(\underbrace{200\pi t}_{\omega})$$

$$m_{\text{AM}} = \frac{U_m}{U_p} = \frac{1}{5}$$



$$\omega = \frac{2\pi}{T} = 24000\pi \rightarrow 200\pi$$

$$P = \frac{U^2}{2R}$$



$$\omega = 2\pi f$$

$$f_p \Rightarrow 2000 \text{ Hz}$$

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

③. 21 - 2011/12

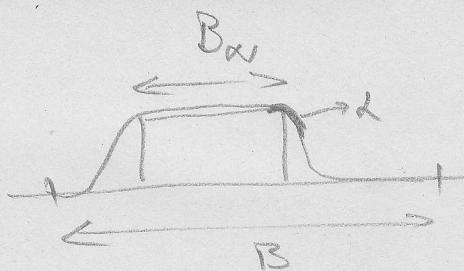
$$R_b = 110 \text{ Mbit/s}$$

$$B = 25 \text{ MHz}$$

$$\lambda = 0,25$$

$$B_N = ?$$

$$R_s = ?$$



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

$$B_N = \frac{B}{1+\alpha} = 20 \text{ MHz}$$

~~PSK~~  
QAM  $\rightarrow B_N = R_s$

$$R_s = 20 \text{ Mbit/s}$$

$$S = \frac{R_b}{B} = \frac{110}{25} = 4.4 \rightarrow \text{maksimalni spektar}$$

$$8PSK \rightarrow 1$$

$$8PSK \rightarrow 2$$

$$8PSK \rightarrow 3$$

$$16PSK \rightarrow 4$$

savjeti:  
- slajdovi, sažeci, zbirka zadataka  
-

QAM