Problem 1

Predpokladajme komunikacny kanal s kapacitou 20 Mbps. Frekvencna sirka kanala nech je 3MHz. Aky musi byt pomer signal/ sum v [dB] podla Shanon zakona aby sme dosiahli danu kapacitu?

$C = B \, ld(1+S/N)$

$20.10^6 = 3.10^6 \, ld(1+S/N)$

$2^{20/3} - 1 = S/N$

$100{,}5936 = S/N$

$S/N \, [dB] = 10\log(100{,}5936) = 20{,}025 \, dB$

Problem 2

Digitalny system pracuje s rychlostou 9600 bps.
(a) Ak kazdy signalovy prvok reprezentuje 4 bity, aka potrebna je minimalna sirka kanala podla Nyquist zakona? (b) Opakujte cast (a) pre 8-bit na signalovy prvok.

$C = 2B \, ld \, M$

a) $9600 = 2B \, ld(16)$

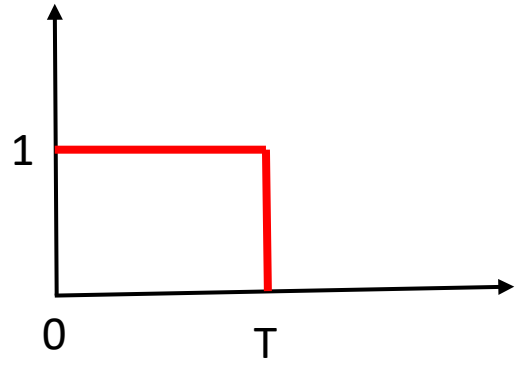
$B = 9600/2.4$

$B = 1200 \text{ Hz}$

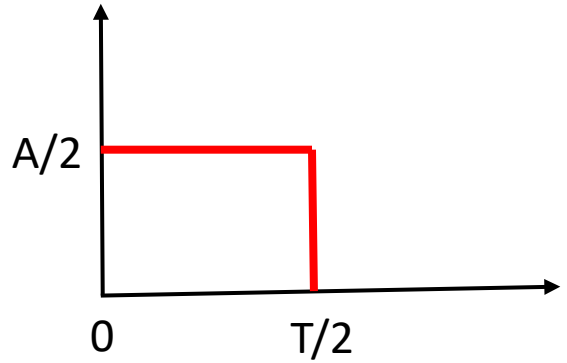
b) $B = 600 \text{ Hz}$

Problem 6

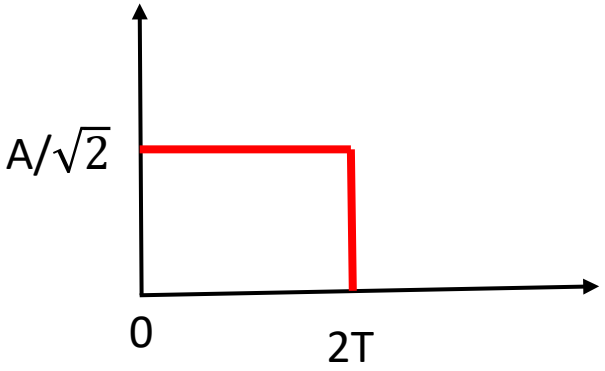
Vypocitajte hodnotu energie E pre jednotlive priebehy impulzov.



$$E = \int_0^T 1\, dt = t\,\Big|_0^T = T$$



$$E = \int_0^{T/2} \left(\frac{A}{2}\right)^2 dt = \frac{A^2}{4}\, t\,\Big|_0^{T/2} = \frac{A^2 T}{8}$$



$$E = \int_0^{2T} \left(\frac{A}{\sqrt{2}}\right)^2 dt = \frac{A^2}{2}\, t\,\Big|_0^{2T} = A^2 T$$

Problem 7

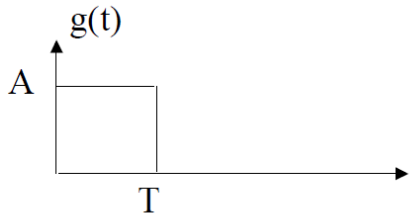
Na zaklade priebehov v pripade a) nakreslite spectrum |X(f)| signalu x(t) podla b).

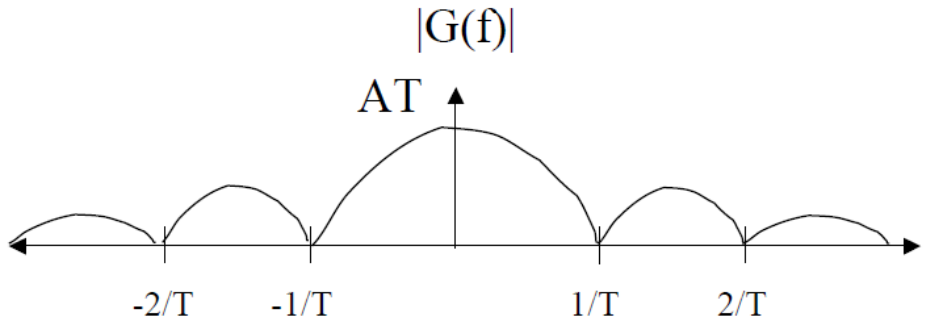
a)

$$G(f) = F[g(t)]$$

$$G(f) = \int_{-\infty}^{\infty} g(t)e^{-j2\pi ft}dt = \int_{0}^{T} Ae^{-j2\pi ft}dt$$

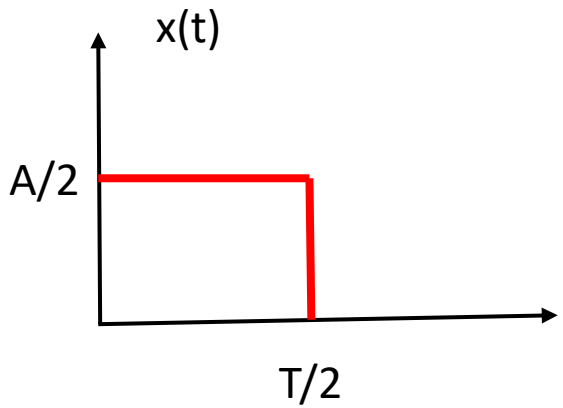
$$G(f) = (AT)Sinc(\pi fT)e^{-j\pi fT}$$

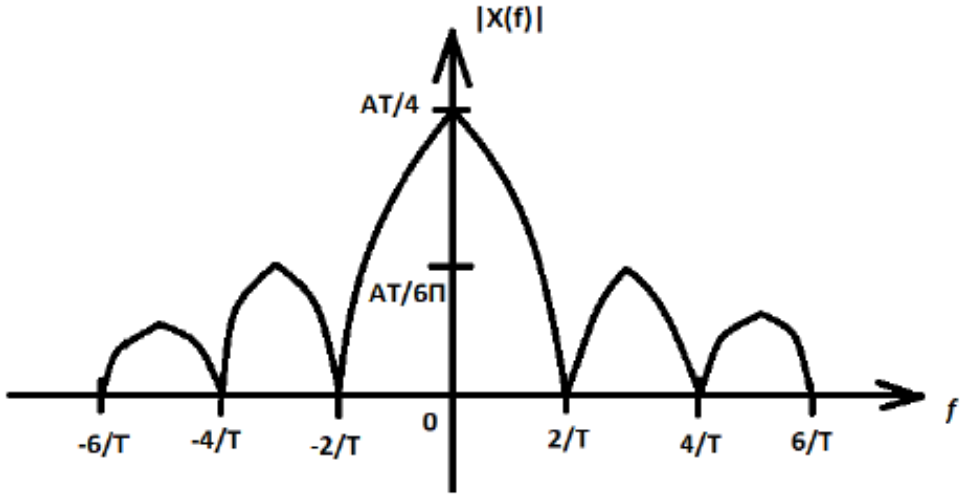


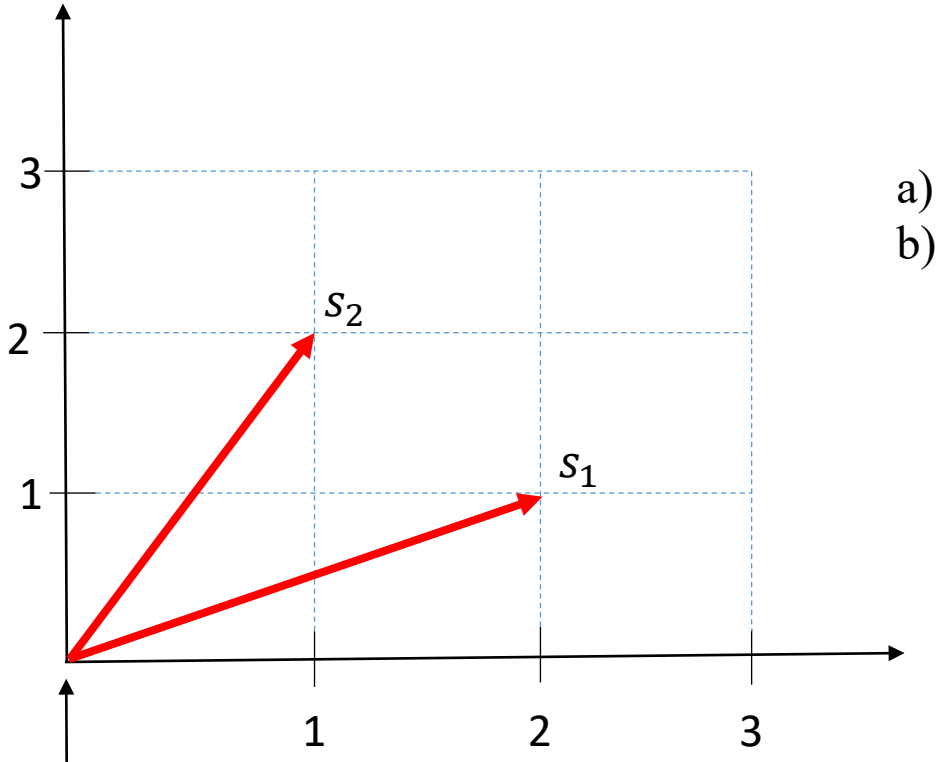


- **Ideal rectangular pulse has unlimited bandwidth**
  - **First "null" bandwidth = 2(1/T) = 2/T**
- **In practice, we "shape" the pulse so that most of its energy is contained within a small bandwidth**

b)



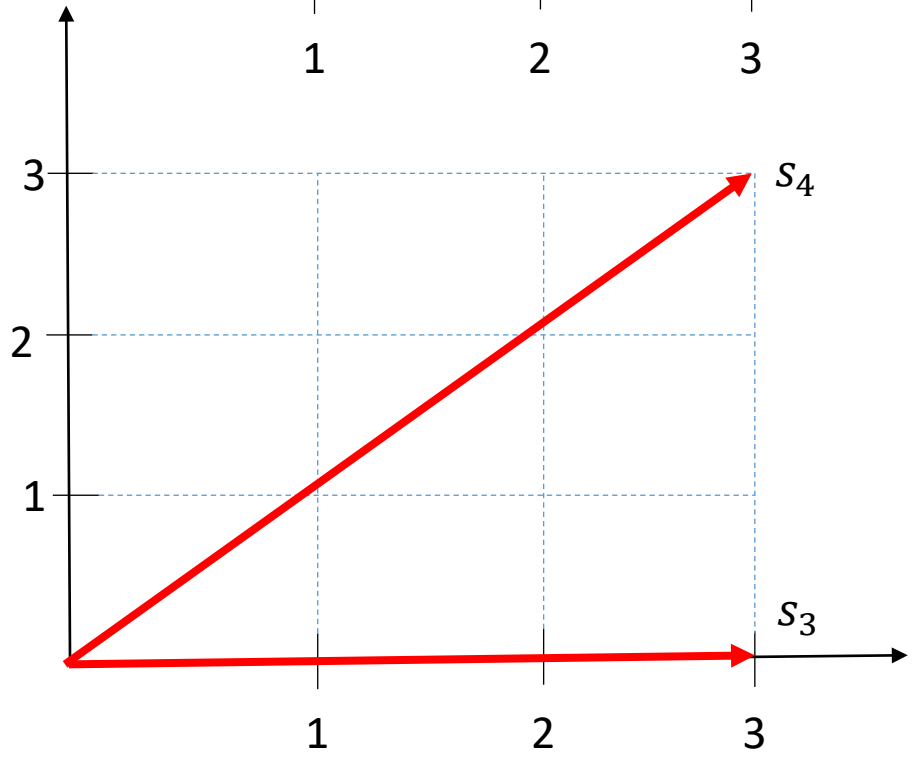




Problem 8

a) Vypocitajte hodnoty energie Es1 a Es2.
b) Vypocitajte Euklidovu vzdialenost *d* medzi vektormi s1 a s2.

$$E_{s1} = \|s1\|^2 = 4 + 1 = 5$$
$$E_{s2} = \|s2\|^2 = 1 + 4 = 5$$
$$d = \sqrt{(x1 - x2)^2 + (y1 - y2)^2} = \sqrt{1 + 1} = \sqrt{2}$$



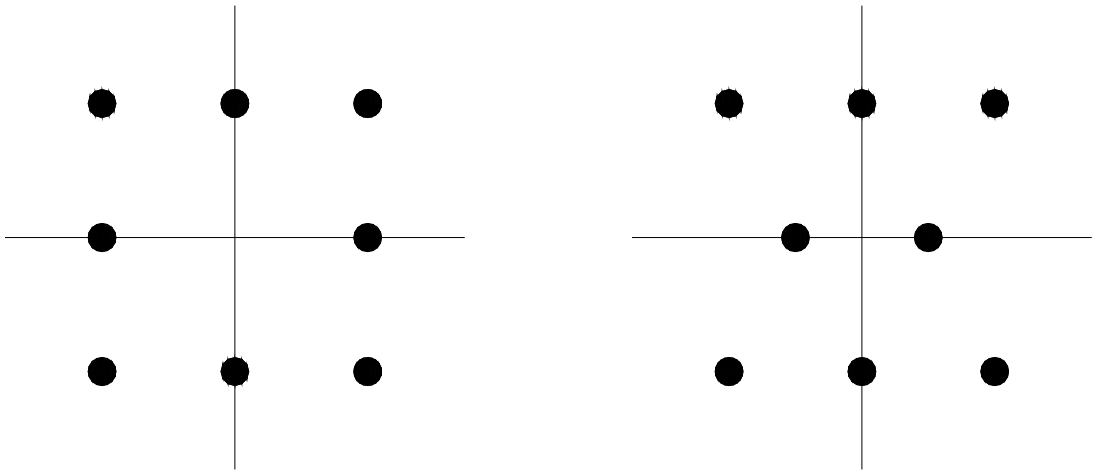
Problem 9

Vypocitajte korelaciu medzi vektormi s3 a s4.

$$Re(p_{km}) = \frac{s_m\, s_k}{\|s_m\|\,\|s_k\|} = \frac{s_m\, s_k}{\sqrt{E_m\, E_k}} = \frac{9+0}{\sqrt{18}\,\sqrt{9}} = \frac{1}{\sqrt{2}}$$

Problem 10

Predpokladajme rozlozenie vektorov (signalovych prvkov) podla obr. a) a b). Je to priklad 8-QAM.
Minimalna Euklidova vzdialenost medzi susednymi vektormi je *2A*.
Vypocitajte priemernu energiu signalu pre konstelaciu a) a b), ak je pravdepodobnost vyskytu prvkov rovnaka.
Pozn. Celkovu energiu este podelit 8



(a) (b)

$E = 6\ A^2$ $E = 5{,}25\ A^2$