6.7-2

PAM $M=8 \Rightarrow n=\log_2 M = 3$

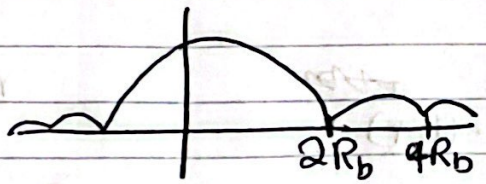
(a) $R_b = 318$ kPbs $\quad BW = \frac{R_b}{2}$

$R_m = \frac{R_b}{\log_2 M} \rightarrow BW_{min} = \frac{R_b}{6} = 53\text{kHz}$

(b) $BW = \frac{R_b}{2 \cdot 3} \cdot (1+r) = 66.25\text{kHz}$

6.7-3

(a)

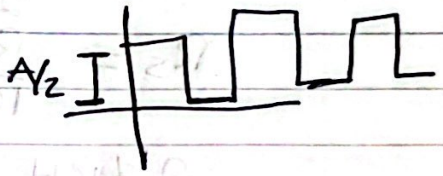


Def:

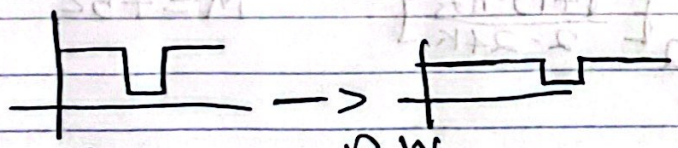
$BW_{min} = R_b/2 \rightarrow$ ~~BW min~~ =

$BW_{actual} = 2R_b$

$P = \frac{(\frac{A}{2})^2 \cdot T_b/2}{T_b} = A^2/8$



(b)(i) Constant Rate



$BW_{m\text{-}arry} = \frac{BW}{\log_2 M}$

(ii) Constant ~~Power~~ Bandwidth

$R_{m\text{-}arry} = R_{binary} \cdot \log_2 M$

$BW_{marry} = BW_{binary}$

$P_{avg} = \frac{E_{avg}}{T} = E_0$

$= \frac{T_s}{M}\left(\frac{A^2}{2}\right)[1+9+25+\ldots]$

6.7-4 $BW_{music} = 18\,kHz$ $f_s = 44.1\,kHz$ $L = 256$

PAM M-array $BW_{max} = 24\,kHz$ $r = 0.2$

$R_b = n \cdot f_s$ $n = \log_2 L$

$BW_b = \frac{n f_s}{2} \cdot (1+r)$

$R_s = \frac{R_b}{\log_2 M} \Rightarrow \frac{(1+r) n f_s}{2 \log_2 M} = BW$

$24\,kHz \geq \frac{(1+r) n f_s}{2 \log_2 M}$

$M \geq 2^{\left[\frac{(1+r)\cdot n f_s}{2 \cdot 24k}\right]}$ $M = 452$

6.7-5

(a) $R_b \rightarrow R_m = \frac{R_b}{\log_2 M} = R_b/4$

$BW = \frac{R_b}{2}$ vs $BW = \frac{R_b}{8}$ $\frac{\frac{R_b}{8}}{\frac{R_b}{2}} = 4$

factor of (4)

(b) $P_b = E_b \cdot R_b = \left(\frac{A}{2}\right)^2 \frac{T_b}{T_b} = A^2/4$

$P_M = \left(\frac{1}{16}\right)(2)\left[\left(\frac{A}{2}\right)^2 + \left(\frac{3A}{2}\right)^2 + \cdots\right]$

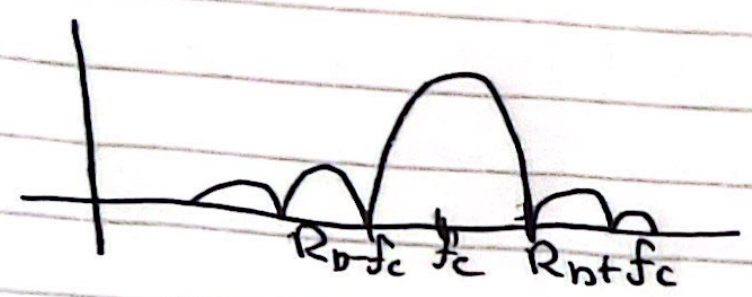
$P_M = (1/16)(2)(A/2)^2[1^2+3^2+5^2+7^2+9^2+11^2+13^2+15^2]$

$P_M = A^2 \cdot 21.25$

$\frac{P_M}{P_A} = \frac{21.25 A^2}{A^2/4} =$ (85)

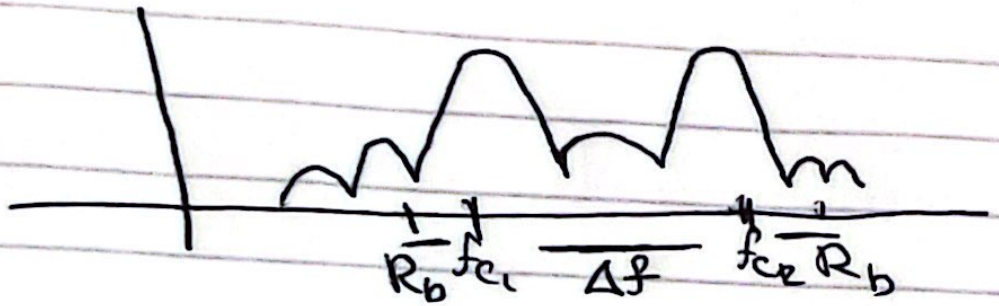
6-8-1

(a)



$BW = 2R_b = 12MHz$

(b)



$\Delta f = 3MHz$

$BW_{fsk} = \Delta f + 2R_b = 15MHz$