Lecture 20 Nov. 23, 2015

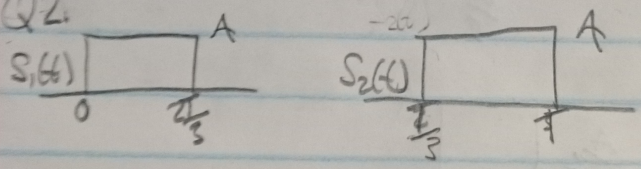
Q1.

$R_{max} = nW\log_2(1+SNR) = 10\times10^6$ b/s

n: 1 bit/s/Hz; $\log_2(1+SNR)$: 6.67 b/s/Hz

$W = \frac{10^7}{6.67}$ Hz $= 1.5$ MHz

Q2.



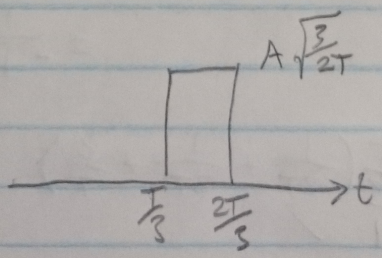
2 basis: $\phi_1(t)$, $\phi_2(t)$

$$E_1 = E_2 = \frac{2A^2T}{3}$$

$$\phi_1(t) = \frac{S_1(t)}{\sqrt{E}} = S_1(t) \times \frac{\sqrt{3}}{A\sqrt{2T}}$$

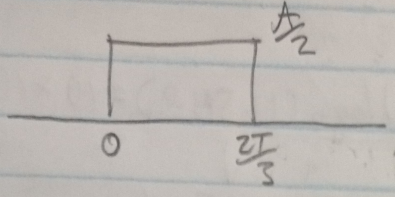
$$\phi_2(t) = \frac{W_2(t)}{\|W_2(t)\|} \qquad W_2(t) = S_2(t) - S_{21}\phi_1(t)$$

$S_2(t)\phi(t)$

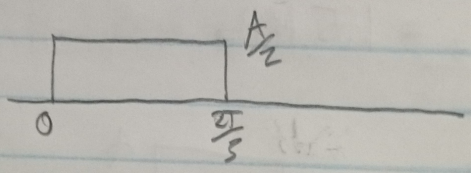


$$S_{21} = A\sqrt{\frac{3}{2T}}\,\frac{T}{3} = A\frac{\sqrt{T}}{\sqrt{6}}$$

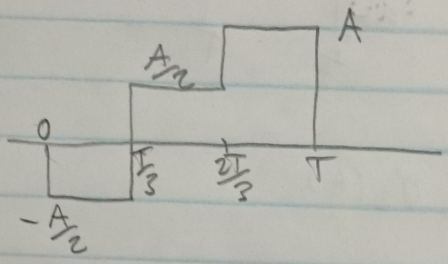
$A\sqrt{\frac{T}{6}}\phi_1(t)$



$S_{21}\phi_1(t)$

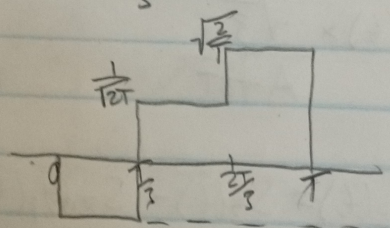


$w_2(t)$



$$\|w_2(t)\|^2 = \frac{T}{3}\left(\frac{A^2}{4}+\frac{A^2}{4}+A^2\right) = \frac{A^2T}{2}$$

$\phi_2(t)$



$-\frac{A}{2}\times\sqrt{\frac{2}{T}}\frac{1}{A}$

$= -\frac{1}{\sqrt{2T}}$

$$\|\phi_2(t)\|^2 = \frac{T}{3}\left(\frac{1}{2T}+\frac{1}{2T}+\frac{2}{T}\right)$$

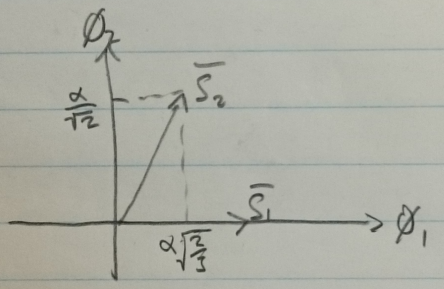
$= 1$ /

$$S_1(t) = S_{11}\phi_1(t) + \cancel{S_{12}\phi_2(t)}^{0}$$
$$= A\sqrt{\frac{2T}{3}}\phi_1(t)$$

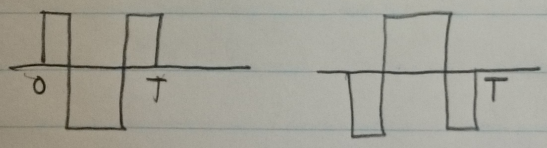
$$S_2(t) = S_{21}\phi_1(t) + S_{22}\phi_2(t) = \frac{A\sqrt{T}}{\sqrt{6}}\phi_1(t) + A\frac{\sqrt{T}}{\sqrt{2}}\phi_2(t)$$

$$S_{21} = \int_0^T S_2(t)\phi_1(t)\,dt$$
$$= \frac{T}{3} \times A\sqrt{\frac{3}{2T}} = \frac{A\sqrt{T}}{\sqrt{6}}$$

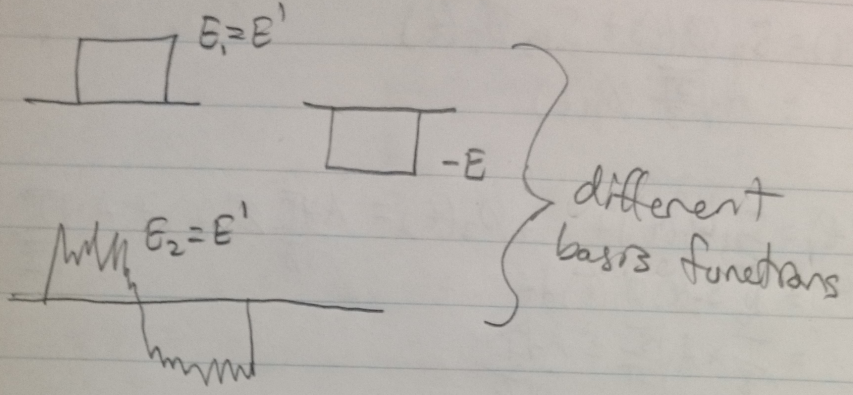
$$S_{22} = \int_0^T S_2(t)\phi_2(t)\,dt$$
$$= \frac{TA}{3}\left(\frac{1}{\sqrt{2T}} + \sqrt{\frac{2}{T}}\right) = \frac{A\sqrt{T}}{3} \times \sqrt{2}\,\frac{3}{2} = \frac{A\sqrt{T}}{\sqrt{2}}$$



⟷ Antipodal Signaling



Antipodal the best we can do.


$E_1 = E'$
$-E$
$E_2 = E'$
different basis functions