Signal Representation

$$\{s_1(t), s_2(t) \cdots s_N(t)\} \longrightarrow \{\bar{s}_1, \bar{s}_2 \cdots \bar{s}_N\}$$

$$\bar{s}_1 = \begin{bmatrix} \alpha_{11} \\ \alpha_{12} \\ \vdots \\ \alpha_{1M} \end{bmatrix}$$

$\bar{s}_1$ → M×1

Basis set of M basis functions

$$\{\phi_1(t), \phi_2(t) \cdots \phi_M(t)\}$$

$$s_i(t) = \sum_{j=1}^{M} \alpha_{ij} \phi_j(t)$$

↑ synthesis inv. formula

where $\alpha_{ij} = \int_0^T s_i(t) \phi_j(t)\, dt$

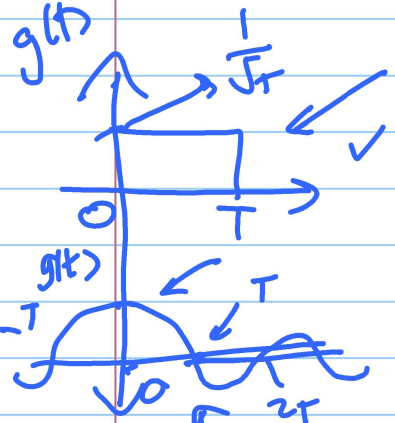
Signal Constellation

$N=4$ (M)

$M=2$

$N = 2^k$

$s_i = \begin{bmatrix} \alpha_{i1} \\ \alpha_{i2} \end{bmatrix}$



$\bar{y} = \begin{bmatrix} \alpha_{11} + n_1 \\ \alpha_{12} + n_2 \end{bmatrix}$

$\times$ y(t) $=$ $s_i(t) + n(t)$

AWGN

$\bar{s}_1 = \begin{bmatrix} \alpha_{11} \\ \alpha_{12} \end{bmatrix}$

y(t)

n(t)

$\phi_1(t)$

$\phi_2(t)$

$t = kT$

$\alpha_{i1} + n_1 \leftarrow N(0, \sigma^2)$

$\alpha_{i2} + n_2 \leftarrow N(0, \sigma^2)$

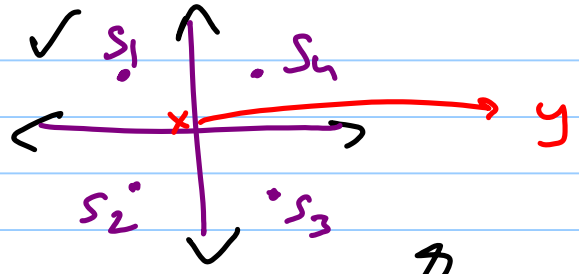
Receiver

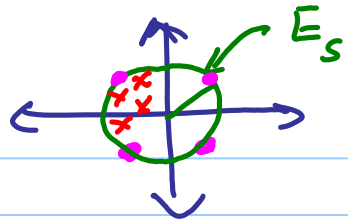
$\phi_2(T-t)$

Circular.

$E[n_1 n_2] = 0$

"Maximise the **Minimum Distance**"





$\hat{s} = s_1$ since $(y - s_1)^2 \leq (y - s_i)^2$, $i = 2, 3, 4$

Optimum Decision Rule / Regions.

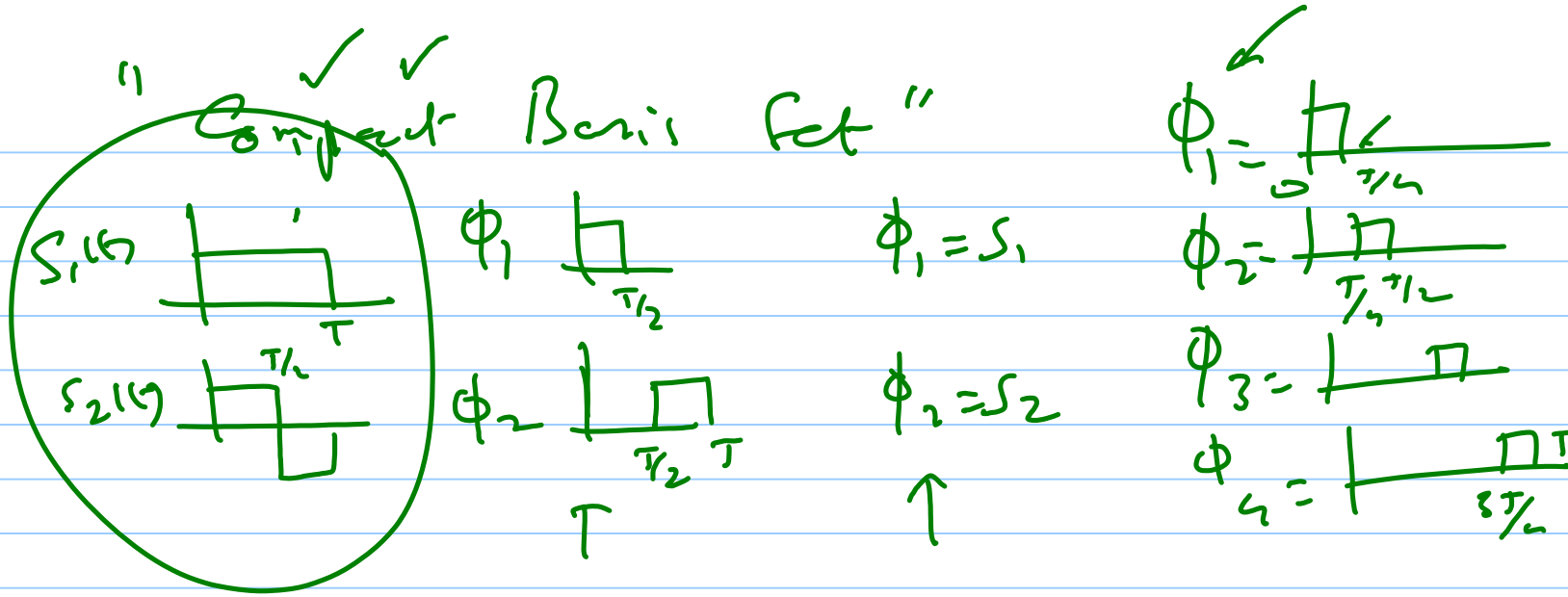
Probability of Symbol Error (Bit)

SER

BER

$\frac{\#\text{ of Symbols in Error}}{\text{Total \# Symbols Sent}}$

$\frac{35}{10,000}$ 35×10^{-4} $= 3.5 \times 10^{-3}$



✓ "Sufficient statistics" ⟵

$$A_{m_I} = (2m-1-M_I)d \quad \text{Tx p-wer}, \quad m = 1 \cdots M_I$$

$$A_{mQ} = (2m-1-M_Q)d, \quad m = 1 \cdots M_Q$$

$$\rightarrow \phi_1(t) = \sqrt{\frac{2}{E_g}} \cdot g(t) \cos 2\pi f_c t$$

$$\rightarrow \phi_2(t) = \sqrt{\frac{2}{E_g}} \cdot g(t) \sin 2\pi f_c t$$

$$s_{m_I} = A_{m_I} \sqrt{\frac{E_g}{2}}$$

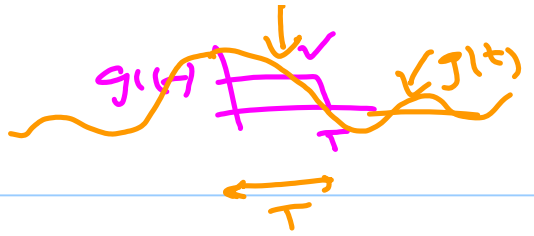
$$s_{mQ} = A_{mQ} \sqrt{\frac{E_g}{2}}$$

$$\int \phi_1^2(t)\,dt = 1$$

$$\int \phi_1 \phi_2 \,dt = 0$$

Linear Digitally Modulated Signals

- PAM
- PSK
- QAM



band-pass

$$s_m(t) = \mathrm{Re}\left\{ \left(A_{mI} + j A_{mQ} \right) g(t)\, e^{j 2\pi f_c t} \right\}, \quad kT \le t \le (k+1)T$$

"T" symbol duration