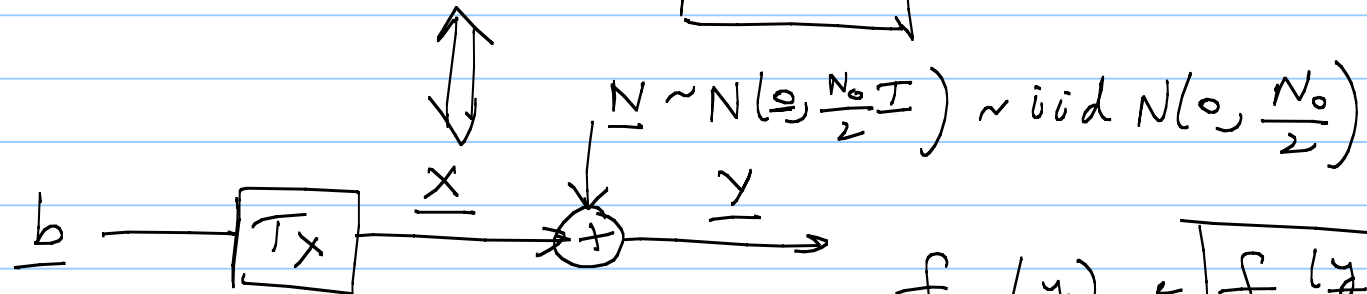
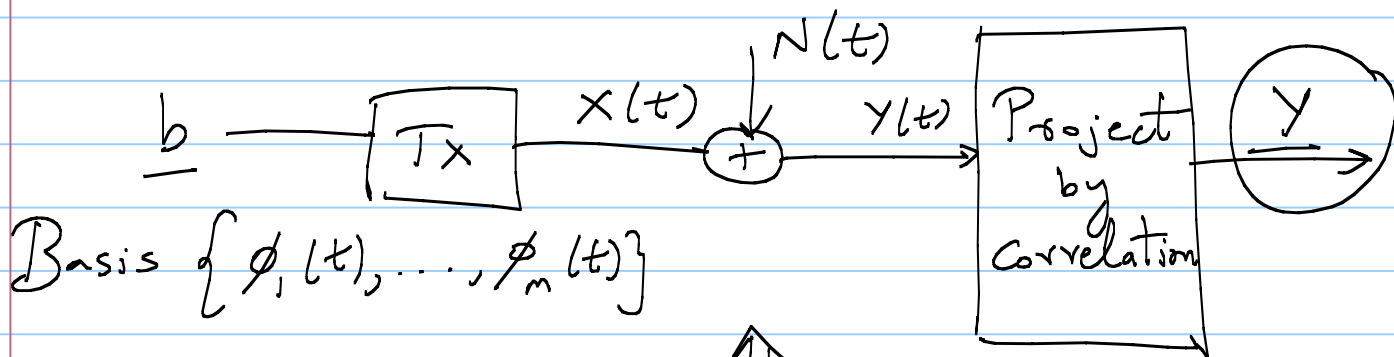


# Lecture 7

Note Title

8/7/2008

$$y(t) = x(t) + N(t)$$



$$\underline{f}_y(\underline{y}) \leftarrow \underline{f}_{y|x}(\underline{y}|\underline{x})$$

$$x(t) = x_i(t) \text{ w.p. } \frac{1}{2^N}$$

$$x_i(t) = \sum_{j=1}^m x_{ij} \phi_j(t)$$

$$\text{Energy of } x_i(t) = \|\underline{x}_i\|^2$$

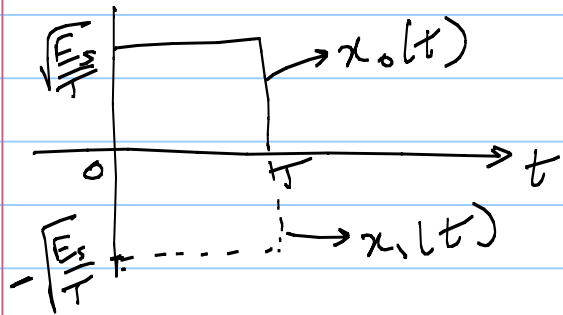
$$\text{Energy of } x(t) = E[\|x\|^2]$$

Examples of Modulators ( $W \gg \frac{1}{T}$ )

1) Binary phase shift keying (BPSK)

$$N=1 \quad \underline{b} = [b]$$

$$x_0(t) = \sqrt{\frac{E_s}{T}}, \quad 0 \leq t \leq T$$



$$x_1(t) = -\sqrt{\frac{E_s}{T}}, \quad 0 \leq t \leq T$$

$$\text{Average energy} = E_s$$

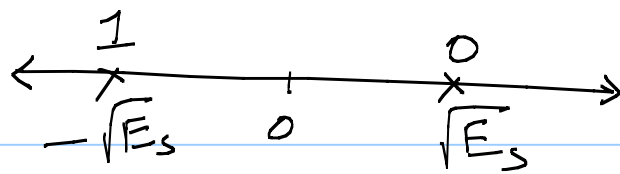
$$BW \gg \frac{1}{T}$$

Gram-Schmidt:

$$M=1$$

$$\phi_1(t) = \sqrt{\frac{1}{T}}, \quad 0 \leq t \leq T$$

$$\underline{x}_0 = [+ \sqrt{E_s}] \quad \underline{x}_1 = [- \sqrt{E_s}]$$



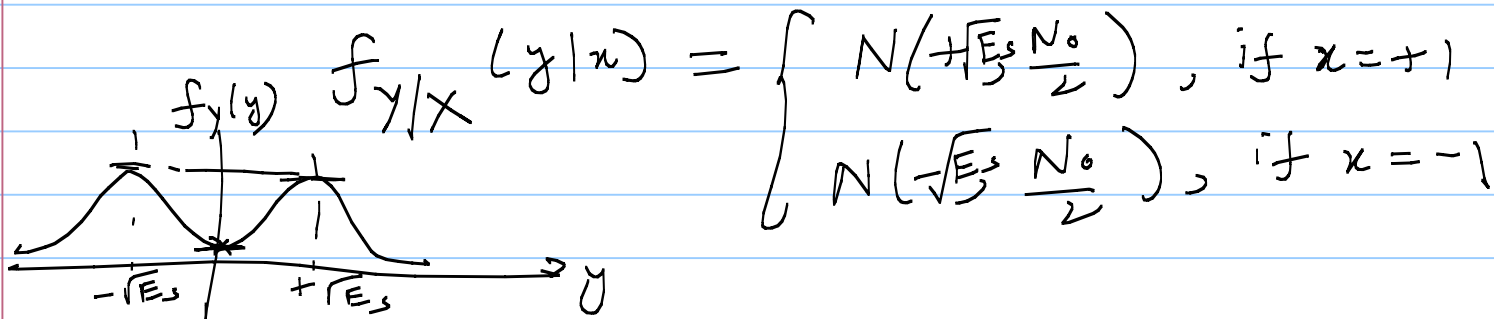
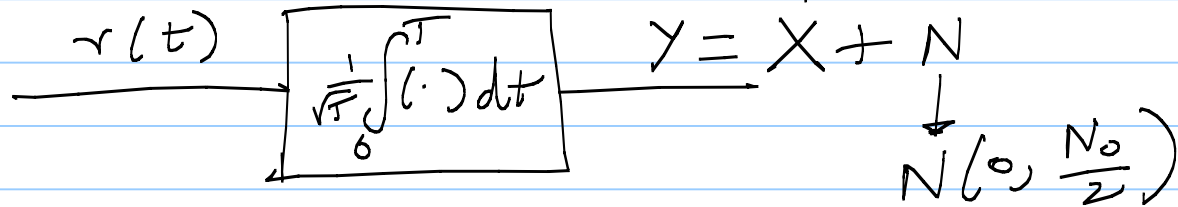
"Constellation"

$$\underline{X} = [x]$$

$$X = \begin{cases} +\sqrt{E_s} & \text{w.p. } 1/2 \\ -\sqrt{E_s} & \text{w.p. } 1/2 \end{cases}$$

$$E[X^2] = E_s$$

Rx:



## ② Frequency Shift Keying (FSK)

$$N=1 \quad b=0 \text{ or } 1$$

$$x_0(t) = \sqrt{\frac{2E_s}{T}} \cos \frac{2\pi m_0 t}{T}, \quad 0 \leq t \leq T$$
$$f_0 = \frac{m_0}{T}$$

$$x_1(t) = \sqrt{\frac{2E_s}{T}} \cos \frac{2\pi m_1 t}{T}, \quad 0 \leq t \leq T$$

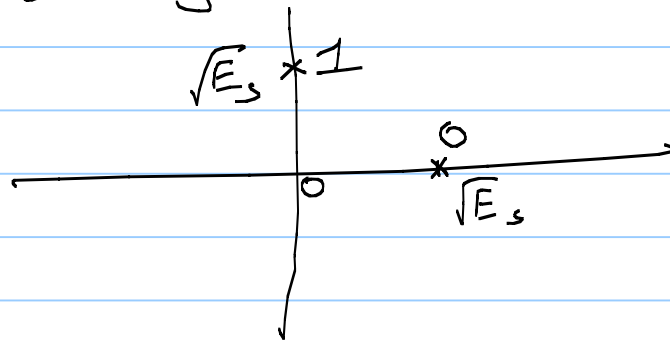
$$f_1 = \frac{m_1}{T}$$

Gram-Schmidt:

$$M=2 \quad \phi_1(t) = \sqrt{\frac{2}{T}} \cos 2\pi f_0 t, \quad 0 \leq t \leq T$$

$$\phi_2(t) = \sqrt{\frac{2}{T}} \cos 2\pi f_1 t, \quad 0 \leq t \leq T$$

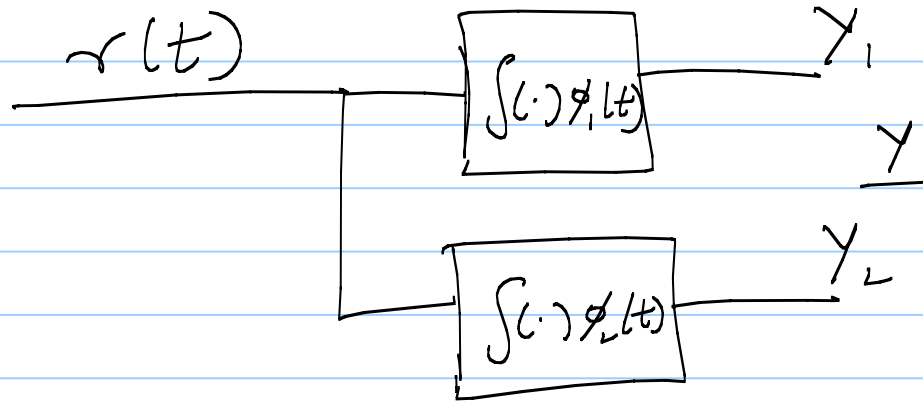
$$\underline{x}_0 = \left[ +\sqrt{E_s} \quad 0 \right]^T \quad \underline{x}_1 = \left[ 0 \quad +\sqrt{E_s} \right]^T$$



"Constellation"

$$\underline{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Rx:



$$\underline{y} = \underline{x} + \underline{N} \quad \underline{N} = \begin{bmatrix} N_1 \\ N_2 \end{bmatrix} \text{ i.i.d } N(0, \frac{N_0}{2})$$