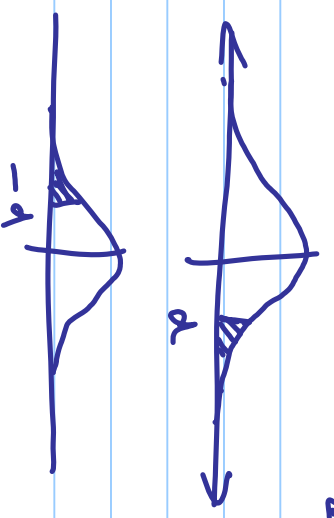


$$P(e) = P(e|s_1)P(s_1) + P(e|s_2)P(s_2)$$

$\frac{P_0}{2}$



Q

$$\frac{1}{2} \operatorname{erfc}\left(\frac{d}{\sqrt{N_0}}\right) \quad \frac{1}{2} \operatorname{erfc}\left(\frac{\sqrt{E_b}}{\sqrt{N_0}}\right)$$

$$Q\left(\frac{d}{\sqrt{N_0/2}}\right)$$

$\frac{E_b}{N_0}$

Signal Power
Noise Variance

SNR

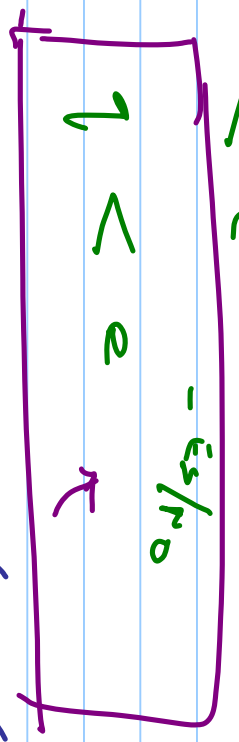
$$2E_b = E_s$$

Chernoff Bound

$$\frac{1}{2} e^{t^2} \left(\frac{d}{\sqrt{2}} \right) < e^{-d^2/2}$$

$$\frac{1}{2} e^{t^2} \left(\frac{d}{\sqrt{2}} \right) \rightarrow e^{-d^2/2}$$

$$d = \sqrt{\epsilon_s} \rightarrow$$



$$\{ \phi_1(t), \phi_2(t) \} \rightarrow s_i = \begin{bmatrix} s_{i1} \\ s_{i2} \end{bmatrix}$$

$$\text{OR } s_i = \begin{bmatrix} s_{i1} + j s_{i2} \end{bmatrix}$$

$$s_i = s_{i1} + j s_{i2}$$

$$\mathcal{N}(0; 0; \frac{n_0}{2}; \frac{n_0}{2}) \rightarrow \text{circular Gaussian}$$

Example:
Complex Case

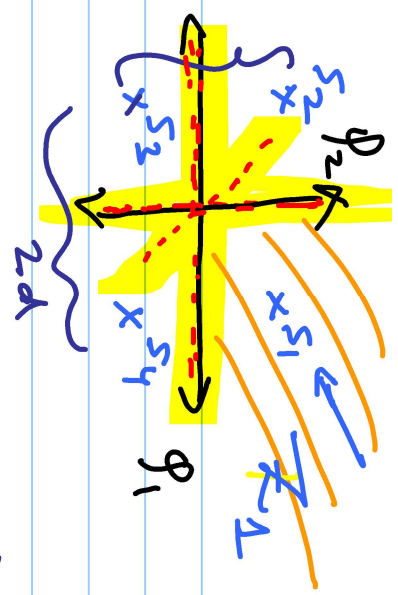
Complex
leads

$$s_i + n$$

$$n_1 + j n_2$$

Example #3
 (BPSK)

$M=4$
 $K=2$

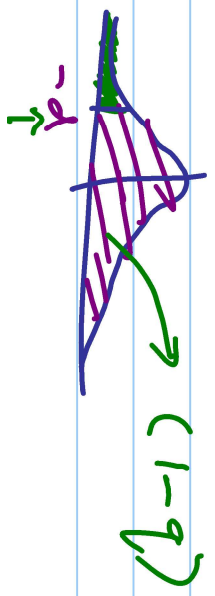
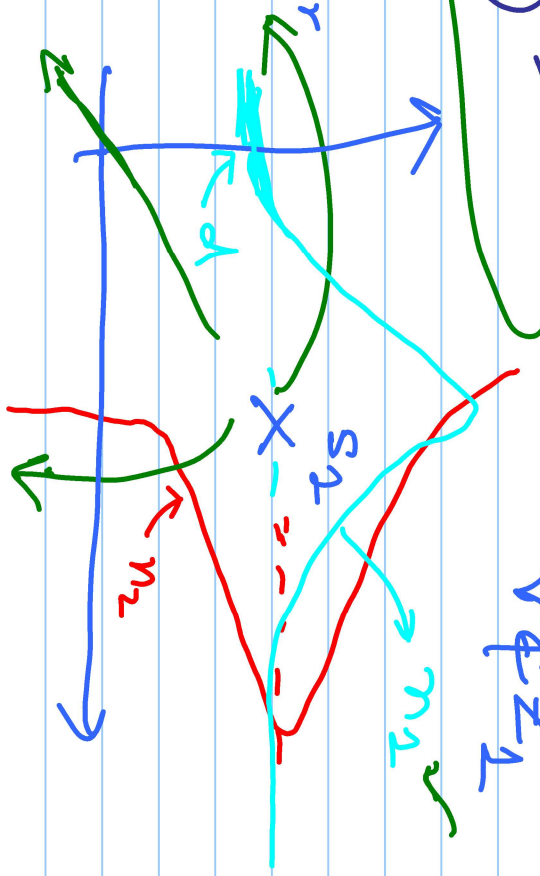


$$\mu_{12} = 0 \checkmark$$

$$P(e) = \sum_{i=1}^4 P(e|s_i) P(s_i)$$

$$P(e|s_1) = \int_{\mathcal{R}_1} P(r|s_1) dr$$

$$P(e|s_1) = \int_{\mathcal{R}_1} P(r|s_1) dr$$



$$P(c|s_2) = (1-q)(1-q)$$

$$P(c) = (1-q)^2$$

$$\Rightarrow P(e) = 1 - P(c) = 1 - (1-q)^2$$

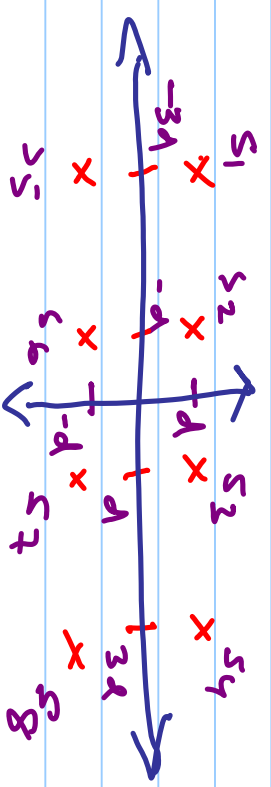
$$= 2q - q^2$$

$$q < 1$$

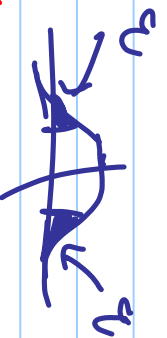
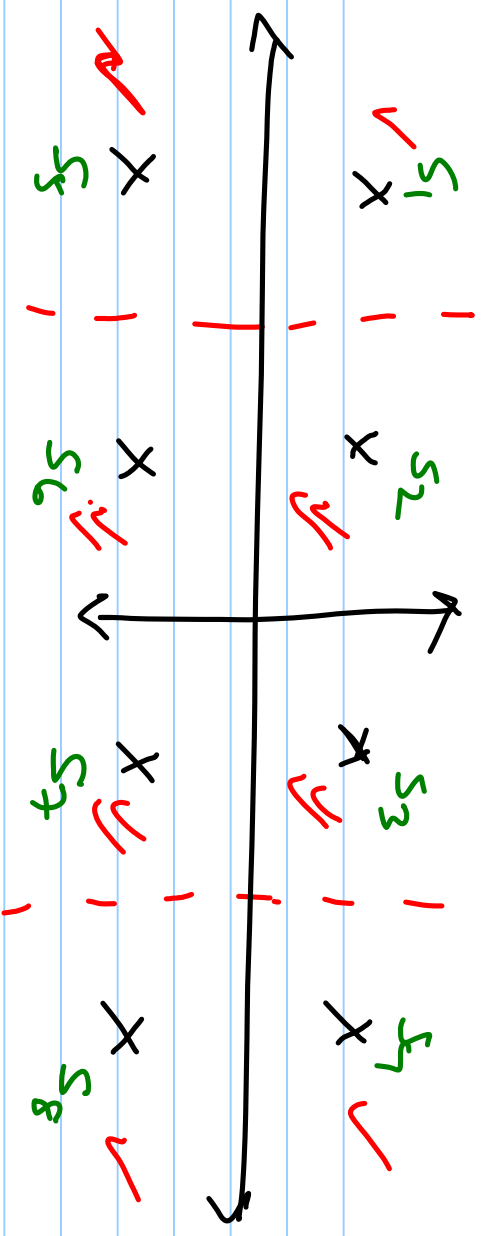
upper bound

Chernoff bound

Example #4
 $P(s_i) = \frac{1}{8} = \frac{1}{n}$



Given $P(c)$ in terms of q



Category 1 ✓

Category 2 ✓

$$P(c | s_i) = (1-q)^2 \checkmark$$

$$P(c | s_i) = (1-q)(1-2q) \checkmark$$

$$P(c) = (1-q)^2 + (1-2q)(1-2q)$$

$$P(e) = 1 - P(c) \checkmark$$

