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ECE300 V1

1. a) $P_e = Q\left(\sqrt{(1-Re(\rho))\gamma_b}\right)$

$P_e = \frac{1}{2} e^{-\gamma_b/2}$

$\rho = -0.217$, $P_e = 10^{-5}$

$10^{-5} = Q\left(\sqrt{(1-Re(-0.217))\gamma_b}\right)$

$\gamma_b = \frac{(Q^{-1}(10^{-5}))^2}{1.217}$

$= 14.946$

$\gamma_b = 10\log(14.946)$

$= 11.745$ dB

b) orthogonal:

$\langle s_1, s_2 \rangle = 0$

$\rho = \frac{\langle s_1, s_2 \rangle}{\varepsilon_b} = \frac{0}{\varepsilon_b} = 0$

$P_e = Q\left(\sqrt{(1-Re(\rho))\gamma_b}\right)$

$10^{-5} = Q\left(\sqrt{(1-Re(0))\gamma_b}\right)$

$\gamma_b = (Q^{-1}(10^{-5}))^2$

$\gamma_b = 18.189$

$\gamma_b = 10\log(18.189)$

$= 12.598$ dB

c) $P_e = \frac{1}{2} e^{-\gamma_b/2}$

$10^{-5} = \frac{1}{2} e^{-\gamma_b/2}$

$\gamma_b = -2\ln(2 \cdot 10^{-5})$

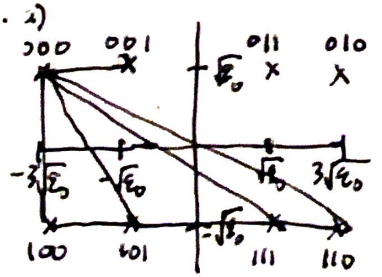
$\gamma_b = 21.6396$

$\gamma_b = 10\log(21.6396)$

$= 13.3525$ dB

2. 135°, 0°, -135°, -90°, -135° for $\pi/4$ DQPSK

3. a)



b) $\varepsilon_s = \frac{1}{M} \sum_{m=1}^{M} \|\vec{s}_m\|^2$

$= \frac{1}{8}(4(2\varepsilon_0) + 4(4\varepsilon_0))$

$\varepsilon_s = 3\varepsilon_0$

$\varepsilon_b = \frac{1}{\log_2 M} \varepsilon_s$

$= \frac{1}{3}(3\varepsilon_0)$

$\varepsilon_b = \varepsilon_0$

c) $2\sqrt{\varepsilon_0} < 2\sqrt{2\varepsilon_0} < 4\sqrt{\varepsilon_0} < 2\sqrt{5\varepsilon_0} < 6\sqrt{\varepsilon_0} < 2\sqrt{10\varepsilon_0}$

$k = [20, 12, 8, 8, 4, 4]$

d) $P_b \le \sum \alpha_i Q(\sqrt{\beta_i \gamma_b}$

$= \frac{1}{3} P_{err}$

$P_{err} = \sum_{i=1}^{M} \sum_{j=1}^{n} P(A_{i,j} / s_i) P(s_i)$

$P_b = \frac{1}{3} \sum_{i=1}^{M} \frac{k_i}{M} Q\left(\sqrt{\frac{d_i^2}{2N_0}}\right)$

$\gamma_b = \frac{2\mathcal{E}_b}{N_0}$

$P_b = \sum_{i=1}^{6} \frac{k_i}{24} Q\left(\sqrt{\frac{q_i^2}{4\mathcal{E}_b} \cdot \frac{2\mathcal{E}_b}{N_0}}\right)$

$\alpha_i = \frac{k_i}{24}, \quad \beta_i = \frac{d_i^2}{4q_0}$

$\alpha_i = [.833, .500, .333, .333, .167, .167]$

$\beta_i = [1, 2, 4, 5, 9, 10]$

e) $\beta_i = 1$

$\alpha_1 = .833$

$P_b = .833 Q(\sqrt{\gamma_b})$

f)