Assignment 10

The due date for submitting this assignment has passed. **Due on 2018-10-10, 23:59 IST.** As per our records you have not submitted this assignment.

1) A QPSK signal over AWGN channel uses one of the four equiprobable signals \( s_i(t) = A \cos(2\pi f_c t + i \frac{\pi}{2}) \), where \( i = 0, 1, 2, 3 \) and \( f_c \) is the carrier frequency, and the duration of each signal is \( T \). Assume input to the QPSK system is a random binary sequence in which symbols/bits 1 and 0 are equally likely, and the symbols/bits in different time slots are statistically independent and identically distributed. Assume channel noise with power spectral density \( \frac{N_0}{2} \). With Gray encoding of the signals, the probability of bit error \( P_b \) is

\[
P_b = Q\left(\sqrt{\frac{2A^2T}{N_0}}\right)
\]

No, the answer is incorrect.

**Score:** 0

**Accepted Answers:**

\[ P_b = Q\left(\sqrt{\frac{2A^2T}{N_0}}\right) \]

If in Question 1, instead of QPSK, binary coherent FSK signals are used with signals \( s_1(t) = B \cos(2\pi f_c t) \) and \( s_2(t) = B \cos(2\pi f_c t + \Delta f t) \) and the minimum value of frequency shift \( \Delta f \) is chosen for which the signals \( s_1(t) \) and \( s_2(t) \) are orthogonal. Determine \( \Delta f \) in terms of \( A \) and \( B \) respectively, so that the bit rate and probability of bit error in both the cases become equal.

\[ \Delta f = \frac{2A^2}{B^2} \]
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3) A QPSK signal over an AWGN channel uses one of the four equiprobable signals $s_i(t) = \begin{cases} \sqrt{2E_b} \cos \left[ 2\pi f_c t + (2i - 1) \frac{\pi}{4} \right], & 0 \leq t \leq T \\ 0, & \text{elsewhere} \end{cases}$ where $i = 1, 2, 3, 4$.

Power spectral density $S_i(f)$ of an offset QPSK signal produced by a random binary sequence in which symbols/bits 1 and 0 are equally likely, and the symbols/bits in different time slots are statistically independent and identically distributed, in terms of the bit energy $E_b$ and bit duration $T_b$, is

$$S_i(f) = E_b \left[ \sin^2 2T_b (f - f_c) + \sin^2 2T_b (f + f_c) \right]$$

$$S_i(f) = 4E_b \left[ \sin^2 2T_b (f - f_c) + \sin^2 2T_b (f + f_c) \right]$$

$$S_i(f) = 2E_b \left[ \sin^2 2T_b (f - f_c) + \sin^2 2T_b (f + f_c) \right]$$

$$S_i(f) = \frac{E_b}{2} \left[ \sin^2 2T_b (f - f_c) + \sin^2 2T_b (f + f_c) \right]$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$S_i(f) = E_b \left[ \sin^2 2T_b (f - f_c) + \sin^2 2T_b (f + f_c) \right]$$

4) A continuous-phase FSK signal is represented by $s(t) = \pm \sqrt{\frac{2E_b}{T}} \cos \left( \frac{\pi t}{T} \right) \cos(2\pi f_c t) \pm \sqrt{\frac{2E_b}{T}} \sin \left( \frac{\pi t}{T} \right) \sin(2\pi f_c t), 0 \leq t \leq 2T_b$. Envelope of the signal is given by

$$\sqrt{\frac{2E_b}{T}} \sin \left( \frac{\pi t}{2T} \right)$$

$$\sqrt{\frac{2E_b}{T}} \cos \left( \frac{\pi t}{2T} \right)$$

$$\sqrt{\frac{2E_b}{T}}$$

$$\frac{2E_b}{T}$$
5) Assuming that both coherent BFSK and MSK have identical performance in terms of bit error probability, the additional amount of bit energy in dB needed for coherent BFSK compared to MSK is ___.

\[ \sqrt{\frac{2^{2M}}{T_b}} \]

6) A speech signal is sampled at a rate of 8 kHz, logarithmically compressed and encoded into a PCM format using 8 bits/sample. The PCM data is transmitted through an AWGN bandpass channel using M-level ASK (assume double sideband transmission) signaling scheme. The channel bandwidth in kHz required for transmission when M=16 is ____.

\[ 16 \]