

Assignment 6

Digital Communication System-I

May 2023

Please answer the following questions:

Q 1: Consider a 4-PAM signalling with each signal having bit energy E_b is transmitted over an AWGN channel with the power spectral density of the channel noise is $N_0/2$. What is the approximated symbol error probability (P_e)

- (a) $2Q\left(\sqrt{\frac{0.9E_b}{N_0}}\right)$
- (b) $2Q\left(\sqrt{\frac{0.703E_b}{N_0}}\right)$
- (c) $Q\left(\sqrt{\frac{0.25E_b}{N_0}}\right)$
- (d) $1.5Q\left(\sqrt{\frac{0.8E_b}{N_0}}\right)$

Q 2: What is the probability of symbol error for QPSK modulated signal for SNR per bit $\left(\frac{\varepsilon_b}{N_0}\right) = 7$ dB ?

- (a) 1.6×10^{-3}
- (b) 4.8×10^{-2}
- (c) 1.18×10^{-2}
- (d) 9×10^{-3}

Q 3: In case of an M-ary PAM modulation, for increasing the transmission rate by 1 bit, one would need 3 dB more power.

- (a) True
- (b) False

Q 4: If the approximate probability of symbol error over AWGN channel for M-ary PSK modulated signal is 2.21×10^{-5} for SNR per bit $\left(\frac{E_b}{N_0}\right) = 9.5424$ dB then find out the value of M ?

- (a) 32
- (b) 16
- (c) 8
- (d) 4

Q 5: Consider the following signal

$$s(t) = \begin{cases} \frac{A}{T} \sin(2\pi f_c t), & \text{if } 0 \leq t \leq T \\ 0, & \text{otherwise} \end{cases}$$

what will be the frequency response of the matched filter?

- (a) $\delta(f + f_c) + \delta(f - f_c)$

- (b) $\frac{1}{2j}[\delta(f - f_c) - \delta(f + f_c)]$
- (c) $\frac{A}{2T}e^{-j2\pi fT} [\delta(f - f_c) + \delta(f + f_c)]$
- (d) $\frac{A}{2jT}e^{-j2\pi fT} [\delta(f - f_c) - \delta(f + f_c)]$

Q 6: Which of the following statement is true regarding QAM modulation scheme?

- (a) For large M , it gives better performance than PSK.
- (b) As M increases, the BER performance improves if SNR keeps constant.
- (c) Constellation diagram of 4-QAM and QPSK are not same.
- (d) None of the above

Q 7: A binary PAM communication system employs rectangular pulses of duration T_b and amplitudes $\pm A$ to transmit digital information at a rate $R_b = 10^4$ bps. If the power-spectral density of the additive Gaussian noise is $N_0/2$, where $N_0 = 10^{-2}$ W/Hz, determine the value of A that is required to achieve a probability of error $P_b = 10^{-4}$.

- (a) 26.31
- (b) 6.91
- (c) 37.19
- (d) None of these

Q 8: Consider the following equal energy orthogonal signalling scheme with $N = M$. What is the distance between any two pair of signalling points in signal space diagram?

$$\begin{aligned} S_1 &= (\sqrt{2E}, 0, \dots, 0) \\ S_2 &= (0, \sqrt{2E}, \dots, 0) \\ &\vdots \\ S_M &= (0, 0, \dots, \sqrt{2E}) \end{aligned}$$

- (a) \sqrt{E}
- (b) $\sqrt{2E}$
- (c) $\sqrt{4E}$
- (d) $\sqrt{8E}$

Q 9: Which of the following is/are example(s) of orthogonal signalling modulation scheme?

- (a) Frequency shift keying (FSK)
- (b) Pulse position modulation (PPM)
- (c) Both (a) and (b)
- (d) None of these

Q 10: Symbol error rate of simplex signalling gives SNR boost over orthogonal signalling by a factor of

- (a) $2M$
- (b) $\frac{1}{M-1}$
- (c) $\frac{M}{M-1}$
- (d) $M - 1$

where M is the number of signals.