XMUT310 Communication Engineering

Tutorial 5: Digital Modulations

Answers are provided for your convenience.

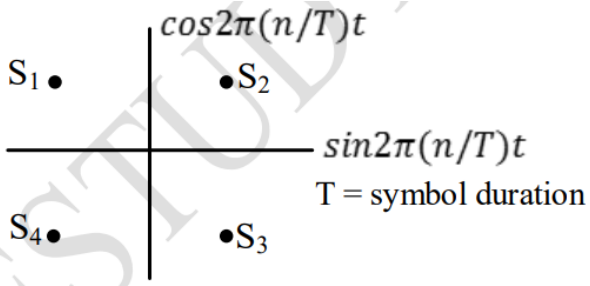
Most solutions can be found in Bilibili
https://www.bilibili.com/video/BV19h411Z7yY/ and
https://www.bilibili.com/video/BV1w54y1t7VP/

Q1. In binary data transmission differential phase shift keying (DPSK) is preferred to PSK because

(a) a coherent carrier is not required to be generated at the receiver
(b) for a given energy per bit, the probability of error is less
(c) the 180^0 phase shifts of the carrier are unimportant
(d) more protection is provided against impulse noise

(Answer: a)

Q2. For the signal constellation shown in the figure, the type of modulation is _____.



(Answer: QPSK)

Q3. Quadrature multiplexing is

(a) the same as FDM
(b) the same as TDM
(c) a combination of FDM and TDM
(d) quite different from FDM and TDM

(Answer: d)

Q4. The bit steam 01001 is differentially encoded using 'Delay and Exclusive-**OR**' scheme for DPSK transmission. Assuming the reference bit as a '1' and assigning phases of '0' and 'π' for 1's and 0's respectively, in the encoded sequence, the transmitted phase sequence becomes

(a) π 0 π π 0
(b) 0 π π 0 0
(c) 0 π π π 0
(d) π π 0 π π

(Answer: c)

Q5. The message bit sequence to a DPSK modulator is 1,1,0,0,1,1 , and a 'Delay and Exclusive-**NOR**' scheme is used. Assuming the reference bit as a '0' and assigning phases of '0' and 'π' for 1's and 0's respectively. The carrier phase during the reception of the first two message bits is π, π. The carrier phase for the remaining four message bits is

(a) π, π, 0, π
(b) 0, 0, π, π
(c) 0, π, π, π
(d) π, π, 0, 0

(Answer: c)

Q6. A video transmission system transmits 625 picture frames per second. Each frame consists of a 400 x 400 pixel grid with 64 intensity levels per pixel. The data rate of the system is

(a) 16 Mbps
(b) 100 Mbps
(c) 600 Mbps
(d) 6.4 Gbps

(Answer: c)

Q7. The bit rate of digital communication system is R kbit/s. The modulation used is 32-QAM. The minimum bandwidth required for ISI free transmission is

(a) R/10 Hz
(b) R/10 KHz
(c) R/5 Hz
(d) R/5 KHz

(Answer: b)

Q8. For a bit-rate of 8 kbps, the best possible values of the transmitted frequencies in a coherent binary FSK system are

(a) 16 KHz and 20 KHz
(b) 20 KHz and 32 KHz
(c) 20 KHz and 40 KHz
(d) 32 KHz and 40 KHz

(Answer: d)

Q9. An M-level PSK modulation scheme is used to transmit independent binary digits over a band-pass channel with bandwidth 100 KHz. The bit rate is 200 kbps and the system characteristic is a raised-cosine spectrum with 100% excess bandwidth. The minimum value of M is _____.

(Answer: M = 16)

Q10. In a baseband communication link, frequencies up to 3500 Hz are used for signaling. Using a raised cosine pulse with 75% excess bandwidth and for no inter symbol interference, the maximum possible signaling rate is symbols per sec is

(a) 1750
(b) 2625
(c) 4000
(d) 5250

(Answer: c)

Q11. Coherent orthogonal binary FSK modulation is used to transmit two equiprobable symbol waveforms $s_1(t) = \alpha \cos 2\pi f 1t$ and $s_2(t) = \text{acos } 2\pi f 2t$, where $\alpha\ is\ 4\ mV$. Assume an AWGN channel with two-sided noise power spectral density $N_0/2 = 0.5 \times 10^{-12}\ W/Hz$. Using an optimal receiver and the relation

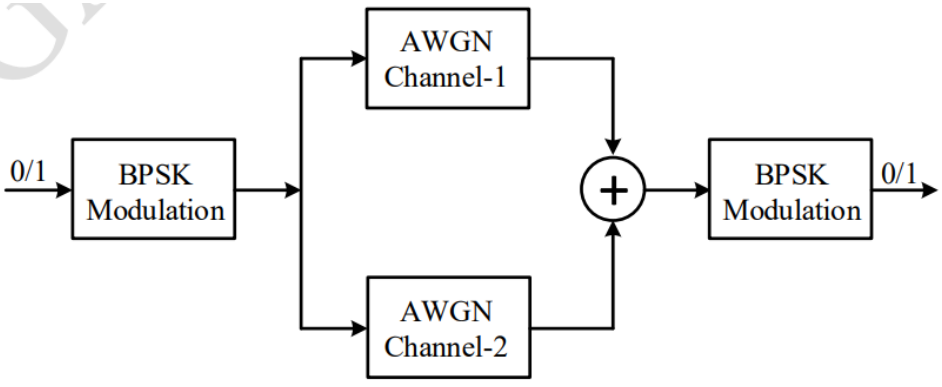
$$Q(v) = \frac{1}{\sqrt{2\pi}} \int_{v}^{\infty} e^{-\frac{u^2}{2}} \text{du},$$

the bit error probability for a data rate of 5000 kbps is

(a) $Q(2)$
(b) $Q(2\sqrt{2})$
(c) $Q(4)$
(d) $Q(4\sqrt{2})$

(Answer: c)

Q12. Let $Q(\sqrt{\gamma})$ be the BER of a BPSK system over an AWGN channel with two-sided noise power spectral density $N0/2$. The parameter γ is a function of bit energy and noise power spectral density. A system with two independent and identical AWGN channels with noise power spectral density $N0/2$ is shown in the figure below. The BPSK demodulator receives the sum of outputs of both the channels. If the BER of this system is $Q(b\sqrt{\gamma})$, then the value of b is_____.



(Answer: b = √2)

Q13. A BPSK scheme operating over an AWGN channel with noise power spectral density of N0/2, uses equiprobable signals

$$S_1(t) = \sqrt{\frac{2E}{T}}\sin(\omega_c t) \quad and \quad S_2(t) = \sqrt{\frac{2E}{T}}\sin(\omega_c t)$$

Over the symbol interval (0, T). If the local oscillator in a coherent receiver is ahead in phase by 450 with respect to the received signal, the probability of error in the resulting system is

(a) $Q\left(\sqrt{\frac{2E}{N_0}}\right)$

(b) $Q\left(\sqrt{\frac{E}{N_0}}\right)$

(c) $Q\left(\sqrt{\frac{E}{2N_0}}\right)$

(d) $Q\left(\sqrt{\frac{E}{4N_0}}\right)$

(Answer: b)

Q14. At a given probability of error, binary coherent FSK is inferior to binary coherent PSK by

(a) 6 dB
(b) 3 dB
(c) 2 dB
(d) 0 dB

(Answer: b)

Q15. Coherent demodulation of FSK signal can be detected using

(a) correlation receiver
(b) band pass filters and envelope detectors
(c) matched filter
(d) discriminator detection

(Answer: a)

Q16. Assume that analogue telephone signal occupies a band from 300 to 3,400 Hz. The signal is to be converted to a PCM signal for transmission over a digital telephone system. What is the minimum sampling frequency?

(Answer: 6.8 kHz)

Q17. In order to allow the use of a low-cost low-pass antialiasing filter with a reasonable transition band, the above telephone signal is oversampled at 8 ksamples/sec. Assume that each sample value is represented by 8 bits.

(a) What is the bit rate of the resulting PCM signal?
(b) What is the minimum absolute bandwidth of this PCM signal?
(c) How can this absolute bandwidth be achieved?
(d) If a rectangular pulse shape is used, the absolute bandwidth is infinity, so we use the first null bandwidth. What is the bandwidth in this case?
(e) Compared with the bandwidth of the original analogue signal, what can you say about the bandwidth of PCM?
(f) What other lesson can you learn from this question?

(Answers: (a) R = 64 kbps (b) B_{min} = R/2 = 32 kHz (c) when a sinc pulse shape is used (d) B_{PCM} = R = 64 kHz (e) original analogue bandwidth is at most 4 kHz, so PCM's is 16 times more (f) Sinc pulse is the optimum pulse shape to use which minimise the bandwidth, whereas rectangular pulse is the opposite; raised cosine pulse is in between these two extremes)