

ITS323 – Quiz 3

Introduction to Data Communications, Semester 1, 2011

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Question 1 [3 marks]

The path between SIIT Bangkadi and SIIT Rangsit is measured to have a power loss of [100 | 100 | 80 | 80 | 110 | 110]dB. Both transmit and receive antenna's are identical, with a gain of [15 | 20 | 10 | 12 | 20 | 15]dBi. Using a transmit power of [5dBW | 10dBW | 10dBW | 10dBm | 12dBm | 12dBW], what is the maximum receive power threshold for successful reception? Show your calculations.

Answer. *Using dB, the gain/loss is additive. That is, starting with a transmit power of 5dBW, with a transmit antenna gain of 15dBi gives 20dBW output. Then a power loss of 100dB leaves -80dBw. Add the gain of the receive antenna gives a receive power of -65dBW.*

Alternative answers are:

- $10dBW + 20dBi + 20dBi - 100dB = -50dBW$
- $10dBW + 10dBi + 10dBi - 80dB = -50dBW$
- $10dBm + 12dBi + 12dBi - 80dB = -46dBm$
- $12dBm + 20dBi + 20dBi - 110dB = -58dBm$
- $12dBW + 15dBi + 15dBi - 110dB = -68dBW$

Question 2 [3 marks]

Amplitude shift keying can be described as: *the amplitude of the analog output signal is dependent on the input digital bit.* Describe frequency modulation.

Answer. *Frequency modulation: the frequency of the analog output signal is dependent on the frequency of the carrier signal and the amplitude of the input analog data.*

Question 3 [3 marks]

You are making a voice call via your computer (e.g. using Skype or similar software). The software, which uses a PCM encoder with [| | 32 | 64 | |] code numbers (or levels), generates data at a rate of [| | 25kb/s | 60kb/s | |].

- (a) What is the sampling period used by the encoder? [3 marks]

Answer. With 32 levels, there are 5-bits per sample. At 25kb/s that means a sampling rate of 5000Hz. The sample period is 0.2ms. The alternative answer uses 6-bits, giving sampling rate of 10kHz and period of 0.1ms.

Question 4 [3 marks]

You are making a voice call via your computer (e.g. using Skype or similar software). The software, which uses a PCM encoder with [| | | 64 | 32] code numbers (or levels), generates data at a rate of [| | | 24kb/s | 100kb/s].

(a) What is the sampling period used by the encoder? [3 marks]

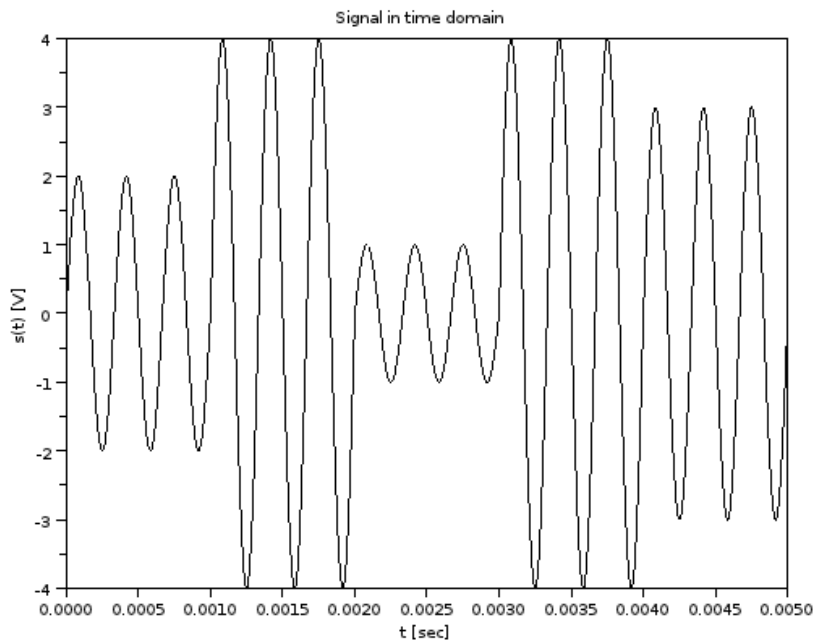
Answer. With 32 levels, there are 5-bits per sample. At 100kb/s that means a sampling rate of 20000Hz. The sample period is 0.05ms. The alternative answer uses 6-bits, giving sampling rate of 4kHz and period of 0.25ms.

Question 5 [4 marks]

The following signal was generated using amplitude shift keying. The signalling rate is 1k signal elements per second. The first four bits of data are [| | 0111 | 0110 | |].

(a) What are the values of the remaining 6 bits? [4 marks] — — — — —

Explain your answer.



Answer. A signalling rate of 1k SE/s means a single signal element is transmitted each 1ms. The signal duration is 5ms and hence there must be 5 signal elements. There are a total of 10 bits, meaning 2 bits per signal element. Hence there are 4 different signal elements, i.e. 4 amplitudes. The first signal element with amplitude of 2 is for the bits 01. The second signal element with amplitude of 4 is for the bits 11. The third signal element with amplitude 1 can represent bits 00 or 10, and so on. In summary the 5 signal elements are those with amplitudes 2—4—1—4—3. Hence the 10 bits are either: 01 11 00 11 10 or 01 11 10 11 00.

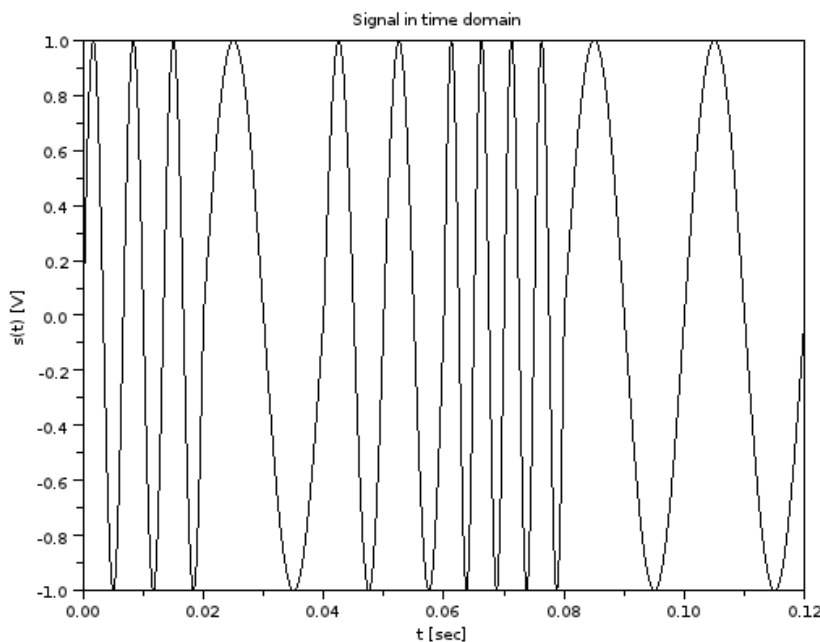
Alternatively, if the first 4 bits are 0110 then the entire sequence is either 01 10 11 10 00 or 01 10 00 10 11.

Question 6 [4 marks]

The following signal was generated using frequency shift keying. The signalling rate is 50 signal elements per second. The first four bits of data are [| | | | 1001 | 0111].

(a) What are the values of the remaining 8 bits? [4 marks] _ _ _ _ _ _ _ _

Explain your answer.



Answer. A signalling rate of 50 SE/s means a single signal element is transmitted each 20ms (0.02s). The signal duration is 0.12s and hence there must be 6 signal elements. There are a total of 12 bits, meaning 2 bits per signal element. Hence there are 4 different signal elements, i.e. 4 frequencies. The first signal element with frequency of 3 is for the bits 10. The second signal element with frequency of 1 is for the bits 01. The third signal element with frequency 2 can represent bits 00 or 11, and so on. In summary the 6 signal

elements are those with frequencies 3—1—2—4—1—1. Hence the 12 bits are either: 10 01 00 11 01 01 or 10 01 11 00 01 01.

Alternatively, if the first 4 bits are 0111 then the entire sequence is either 01 11 00 10 11 11 or 01 11 10 00 11 11.

Question 7 [4 marks]

You record a 1 hour live musical concert using your laptop, using PCM and saving to an (uncompressed) .wav file.

- (a) If using [10-bit | 12-bit | | |] encoding, sampling at [20kHz | 10kHz | | |], how large is the saved .wav file? [3 marks]

Answer. Each sample is 10 bits, there are 20,000 samples per second and there is 1 hour of samples. Hence the number of bits recorded is:

$$10 \times 20,000 \times 60 \times 60 = 720,000,000\text{bits} = 90\text{MB}$$

The alternative answer is:

$$12 \times 10,000 \times 60 \times 60 = 432,000,000\text{bits} = 54\text{MB}$$

- (b) If the music ranged in frequencies from [200Hz | 1kHz | | |] to [15kHz | 20kHz | | |], what is the ideal sampling rate? [1 mark]

Answer. The ideal sampling rate should be twice the highest frequency component, 15kHz, which is 30kHz. The alternative answer is 40kHz.