S-38.110 Telecommunication Switching Technology I, Exercise 1

Brax/Ilvesmäki Fri 25.1.2002 0915hours, lecture hall S4.

The answers are to be returned before the exercise begins (see the above date and time) either to the exercise assistant (in person or via email to lynx@tct.hut.fi) or, preferably, to a box underneath the lab's noticeboard on G-wing 2nd floor. Since we aim to publish the solutions immediately after the exercise, all late answers will be disregarded. Please, adhere to the deadline.

Task 1 (easy)

Following the Nyquist sampling theorem, what should be the sampling rate for the following systems:
a) Voice channel from 300 Hz to 3400 Hz and
b) 4,2-MHz video channel.

Task 2 (easy)

Which voltage levels do the following A-law PCM Coded numbers correspond to, if the maximum amplitude is 1,0 V.
1 000 1101
1 001 1101
1 111 1101
0 000 1101
0 001 1101
0 111 1101

Task 3 (moderate)

a) What is the quantization error for a single sample (in volts) in a PCM-system with 8 bit A/D-converter with a step size of 0.38V.
b) A 2V peak signal (peak values at +2 and –2 volts) with 0V dc offset is to be sampled. Assuming a 4 bit codeword, size the A/D-converter, compute the step size and quantization error. Remember, you need a sign bit to represent the negative (and positive) signal values.

Task 4 (hard)

a) It is usually taken for granted that the relation of the average power of quantization distortion to the average signal power is known to be 20*log2*n, where n is the amount of sample bits. Show that this is actually the case. The quantization step q=2 and the average of quantization distortion is assumed to be zero. You may want to know that the average power is calculated according to

$$I_{power} = \sqrt{\frac{1}{T}\int_0^T i(t)^2\,dt}\ .$$

b) Determine the S/N –ratio for a sinewave signal of p-to-p amplitude of 2V quantised into L levels. Assume linear quantization.