Exercise 11

a) A signal to be sampled and digitized is band limited to $f_s/2$ and varies in amplitude between -1 V and +1 V. The signal is noisy with noise level 1 mV in RMS. We will use an A/D converter with dynamic range ± 1 V. Assume that the cost of the A/D converter is higher if more bits of resolution are used. We want to have the least possible extra noise on the signal after the digitization, and at the same time, use an inexpensive converter. Which converter would you suggest if we can choose between 8, 12 and 16 bits? Justify your answer. (The total power of multiple independent signal sources equals to the sum of the individual power of each source.)

b) We want to digitize an analog signal. The RMS value of the signal is 0.4 V and the AD has dynamic range of ± 1 V. What S/N would you expect after digitization if a 12 bit A/D is used?

c) A signal in the frequency range 10 Hz to 800 Hz is sampled at rate 10 M samples/second. The samples are quantized in an 8 bit linear AD converter. The dynamic range of the converter is ± 1 V and the RMS of the signal is 0.5 V. Find the S/N of the quantized signal.

d) The quantized signal in c) is low pass filtered with bandwidth 1 kHz. Find S/N of the signal after the LP filter.

e) Why is non-linear AD converters sometimes used instead of linear converters.