Measuring systems

Problem set n°12

Comparison of measured data

Exercise 1 (Noise due to capacitive coupling)

A signal of bandwidth B_p perturbs a stationary voltage by capacitive coupling, which we want to measure. The signal is then passed through a low-pass filter. We measure the effective value of the desired signal before filtering ($U_{b,A}$, with N_A samples) and after filtering ($U_{b,B}$, with N_B samples).
Does filtering reduce the noise significantly (risk of error α)?

Numeric data:

$B_p \in [0.5; 100\ kHz]$

$U_{b,A} = 10\ \mu V$

$N_A = 10$

$\alpha = 1\ ‰$

$U_{b,B} = 3\ \mu V$

$N_B = 20$

Exercise 2 (Asymmetric amplifier)

We want to amplify a stationary voltage U (value known *a priori*) using an asymmetric amplifier with gain A that generates a noise Φ_n with bandwidth B_n in output (values provided by the manufacturer). Moreover, the temperature interferes on the output offset of the amplifier as a consequence of $\varepsilon_{\Delta T}$ (reference temperatureT_{ref} of 25 °C). We measure this output voltage with a voltmeter, which provides a signal averaged over N values.

a) Calculate the average experimental voltage as a function of temperature and the standard deviation of the output voltage.

b) What is the appropriate temperature range if we want to prove that the offset is not a systematic error with an error risk α?

Numerical data:

$\Phi_n = 100\ \ \mu V/\sqrt{Hz}$

$\mathrm{B}_n = [0; 100\ kHz]$

$N = 20$

$A = 60\ dB$

$U = 1\ mV$

$\varepsilon_{\Delta T} = 0.3\ mV/°C$