Problem 1

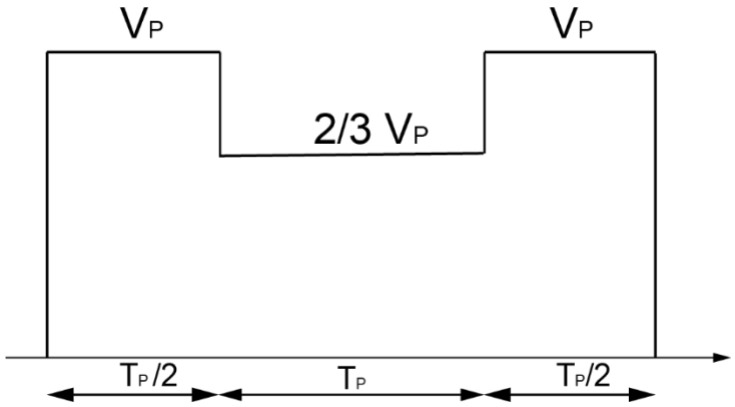
We want to measure the amplitude V_p of the signal shown in the figure below (T_p=1µs), in the presence of white noise (unilateral spectral density $\sqrt{S_V} = \frac{10nV}{\sqrt{Hz}}$) and 1/f^2 noise with f_c=2MHz.

a) Calculate the minimum measurable amplitude V_p exploiting the best theoretical filter.
b) Calculate the minimum amplitude V_p that can be measured in two cases i) being able to use a single gated integrator; ii) having the possibility of exploiting three gated integrators having the same duration T_G. In both cases passive filters and auxiliary linear electronics are available, if needed.
c) Describe in detail from the theoretical point of view how the CDF works, its weighting function and the effect on the white noise of its different parameters.

Problem 2

We want to measure for one continuous hour the longitudinal deformation of a mechanical piece that occurs with time scales of a few seconds. To this aim, it is possible to use strain gauge sensors, amplifiers with 100MHz bandwidth and noise consisting of a wideband component (unilateral spectral density $\sqrt{S_V} = \frac{10nV}{\sqrt{Hz}}$) and 1/f noise with corner frequency f_c= 2kHz. A continuous power supply up to 3.3V is available.

a) After having designed and sized the measurement setup, evaluate the minimum measurable deformation by quantifying the contribution of the 1/f noise compared to the white noise one.
b) Considering now that you also have available sinusoidal and square wave modulating signals at a frequency of 100kHz with the same amplitude, modify the setup to improve the situation in point a) as much as possible, considering that it is now possible to acquire the signal even just one time per second but that now the signal of interest is accompanied by a sinusoidal strong disturb at a frequency of 2.5Hz.
c) Describe in detail, from theoretical point of view, both in the time domain and in the frequency domain, how it is possible to obtain the weighting function of a Lock in amplifier.



Signal Recovery