Problem 1

A sensor system emits triangular voltage signals having the shape shown in Figure 1 with **2Tp = 10µs** and variable amplitude. The emission of each pulse is notified by an auxiliary signal. The available amplifier has a bandwidth of 200 MHz and input referred noise generator featuring **unilateral** spectral density $\sqrt{S_V} = 4nV/\sqrt{Hz}$.

1) Choose a practical filter and calculate the minimum detectable signal comparing the results with the optimum one.

2) Consider now that sensor emits the signals with a period of 10kHz and the amplitude slowly varies with a timescale of 1s. Evaluate whether it is possible to improve the measurement with respect to point 1) both for the chosen filter and for the optimum one.

3) Considering now also the presence of **1/f noise with fc = 2kHz**. Change the filtering, if necessary, to minimize its effect on the final measurement.

Problem 2

We want to detect the power of a slow optical signal (bandwidth of 100 Hz) at 500nm using an APD. The detector is connected to an amplifier with 2pF input capacity and 10kOhm input resistance. The amplifier has a bandwidth of 10MHz and input referred noise generators featuring **unilateral** spectral density $\sqrt{S_V} = 4nV/\sqrt{Hz}$ and $\sqrt{S_I} = 1pA/\sqrt{Hz}$.

1) Choose the characteristics of the detector for this application. Design the filter that can be used to read the signal and calculate the minimum detectable current signal. How can this information be converted into optical power incident on the detector?

2) Considering now also the presence of **1/f noise with fc = 2kHz** at the preamp input. Evaluate the effect of the 1/f noise and how much can be reduced using an initial zero setting considering measurement of duration varying from 20 min to 2 hours.

3) Since the signal comes from the excitation with a constant laser diode. Evaluate how to improve the measurement having the possibility to modulate the laser. Choose the best solution describing it in detail and calculating the minimum detectable current signal.

Fig. 1

Signal Recovery