Problem 1

A triangular signal as shown in the figure below ($\mathbf{2T_P = 100ns}$) is coming from a low-impedance source. The signal is fed to a voltage preamplifier featuring wideband noise with unilateral spectral density $\sqrt{S_V} = \frac{10nV}{\sqrt{Hz}}$. A sync signal is available.

1) Select the bandwidth of a suitable preamplifier for extracting the signal and evaluate the minimum measurable amplitude $V_{P,min}$ that can be obtained exploiting a gated integrator.
2) Consider now that the preamp is affected by 1/f noise with $f_C = 10kHz$ and the source emits every second a burst of 10 pulses with a time between pulses that can change between 20 and 100 ns from pulse to pulse. The pulse amplitude is constant within each burst while it varies significantly from burst to burst. Select a filter that properly exploits the available information and evaluate the minimum measurable amplitude $V_{P,min}$ in this case.
3) From a theoretical point of view, describe the weight function of a CDS filter in the time domain and its effects on the noise as a function of the correlation time.

Problem 2

A periodical pulsed laser emits rectangular pulses at 400nm featuring a repetition rate of 100kHz. The duration of each pulse is **20ns.** The light signal is sent towards targets placed in turbid water and photodetectors are used to locate such objects by measuring the time of flight of the light pulses. A 100% reflection from the target and no attenuation from the water can be assumed for simplicity. The signal readout consists of a preamplifier featuring

$R_{IN} = 50\Omega, \sqrt{S_V} = \frac{2nV}{\sqrt{Hz}}, \sqrt{S_I} = \frac{0.5pA}{\sqrt{Hz}}$.

1) Being able to choose between a photodiode and a phototube, discuss what would be the most appropriate detector for this application. Describe the best filtering action that is necessary to extract the information carried by each pulse **individually** and evaluate the minimum laser power that has to be sent towards the target to detect the position of the target. Use reasonable values for any omitted parameter.
2) Consider now the exploitation of a PMT and a simple constant-parameter filter: discuss how this choice would change the situation with respect to point a, choose suitable detector parameters and provide a quantitative evaluation of the minimum laser power that has to be sent towards the target in this case.
3) From a theoretical point of view, describe in detail the concept of NEP and its usefulness.