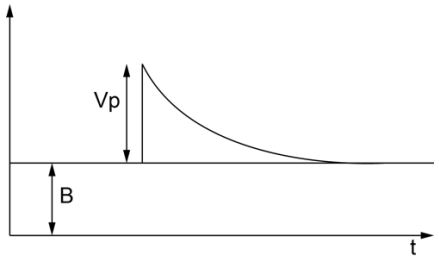
(NB: see text also on the other side of the sheet)

Problem 1

Pulse signal Exponential signal V_P variable pulse amplitude B constant Sync available τ=10μs **Preamplifier** $S_V^{½} = 20nV/Hz^{1/2}$ white noise spectral density (unilateral) $f_{pa} = 50\ MHz$ upper band-limit	

A) Considering only the exponential signal, with **B=0**, select the best Gated Integrator in order to obtain the minimum signal that can be detected with this solution. Describe each step quantitatively.

B) Consider now to have an **unknown background B**. Discuss if and how it is possible to extract the pulse amplitude information. Compare the results with the result obtained in point A and discuss the impact of the new proposed solution on the minimum signal that can be detected.

C) Consider now the same signal but with a repetition rate of 1kHz and the amplitude Vp that slowly changes in the time scale of a few seconds. How it is possible to use this information to reduce the minimum detectable signal? Propose a solution, select the parameters and quantitatively evaluate the results that can be obtained.

D) Explain in detail the concept, the weighting function and the low frequency cut-off of the CDS (Correlated Double Sampling). Describe the effect of the CDS on band-limited white noise with a time domain analysis.

(NB: see text also on the other side of the sheet)

Problem 2

	PREAMPLIFIER $S_V^{½} = 20nV/Hz^{1/2}$ white noise power density (unilateral) 1/f frequency corner: 10KHz $f_{pa} = 50\ MHz$ upper band-limit

We want to measure the temperature of a small apparatus using a PT100 sensor with a Wheatstone bridge configuration. The resistance of the sensor at the desired temperature is 120 Ohm and the bias of the bridge is 25mV.

A) Assuming that the temperature signal can change on the time scale of 1 second, evaluate the minimum variation of temperature that it is possible to measure. Additional analog or digital stages can be used, if needed.

B) Consider now a sinusoidal bias of the bridge featuring the same amplitude of the steady state signal previously used (i.e. 25mV) and frequency 100 kHz. **It is possible to sample the output of the bridge only 100 times without using any additional filter**. Select the time instants of the sampling points and evaluate the minimum detectable signal with the proposed solution.

C) Consider now that it is possible to use either a Lock-in Amplifier or a resonant filter. Discuss which filter is more suitable in this case, select its parameters and evaluate the minimum signal that can be detected with the proposed solution.

D) Discuss if and how it is possible to use PN junctions instead of PT100 as temperature sensors in this application.