Problem 1

A system featuring a microcontroller is used to a acquire triangular signal having the shape shown in Figure 1 with **2Tp = 10µs**. The maximum sampling frequency of the microcontroller is 500kHz. An auxiliary signal synchronous to the beginning of the signal of interest is available.

1) Choose a suitable preamplifier to extract the signal from the sensor. Then, discuss the design of a gated integrator in the digital domain, choose the appropriate sampling frequency and calculate the minimum signal that can be measured in this condition.

2) Consider now the possibility of choosing the weight of each sample. Evaluate whether it is possible to improve the measurement with respect to point 1) and, if necessary, calculate the new minimum signal that can be measured.

3) Discuss, **in the frequency domain,** the effect of a finite sampling frequency on the acquisition of the signal. Then, explain what would be, and **why**, the minimum measurable signal if such limitation was (theoretically) removed.

Problem 2

Within a mechanical system, a component is subject to periodic stress characterized by **1ms of compression followed by 1ms of extension having the same value with respect to the rest position** (see Fig. 2). The amount of compression/extension slowly varies over time with a band of about 10Hz. We want to design a system for measuring this stress. The available 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) Having strain gauges sensors available (as much as you want) and a power budget of 1µW, choose the hardware configuration to be used, explaining in detail the design choices relating to the setup. **Motivate** any single choice.

2) Identify a filtering that allows you to measure the stress variations with high sensitivity and evaluate the minimum measurable strain.

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.

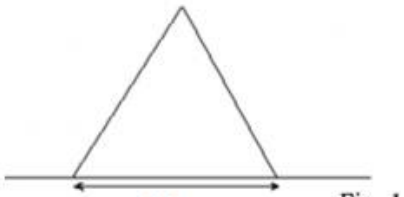

Fig. 1

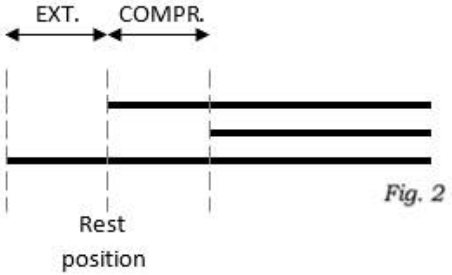

Fig. 2

Signal Recovery