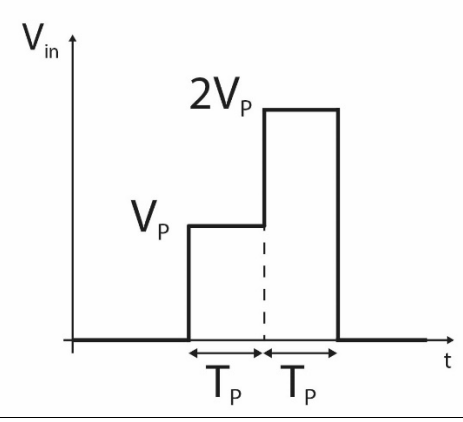
(NB: see text also on the other side of the sheet)

Problem 1

Signal V_P variable pulse amplitude T_P = 600ns **Noise** $S_V^{½} = 10nV/Hz^{1/2}$ white noise spectral density (unilateral) B/f^2 component, with f_C=3MHz **Preamplifier** $f_{pa} = 150\ MHz$ upper band-limit	 Fig. 1

A signal featuring the shape reported in figure 1 is acquired by a preamplifier having a single pole at 150MHz. The overall superimposed noise at the input of the preamplifier has both a wideband and a B/f^2 component with the characteristics above specified.

A) Evaluate the minimum measurable amplitude $V_{P,MIN}$ without using any additional filter.

B) Describe and explain the ideal filter that makes it possible to measure the pulse amplitude V_P with the best possible Signal-to-Noise ratio and evaluate the minimum amplitude $V_{P,MIN}$ thus measurable.

C) Consider now the possibility to exploit a Gated Integrator: if you could open **a single integration window** of arbitrary duration, how would you use this filter to improve the SNR? Explain the proposed solution, select the filter parameters and evaluate the minimum amplitude $V_{P,MIN}$ thus measurable.

D) Consider now a different noise spectrum: it features a B/f^3 noise component instead of a B/ f^2, with the same corner frequency. Propose and discuss a solution to obtain a good SNR

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

Problem 2

The force used to compress or extend a metal body is to be measured. The power supply of the transducer is 5V.

A) Considering the exploitation of strain gauges with R=300Ω and a continuous bias, design and describe in detail the system that you would use to measure the signal of interest.

B) With the same system of point A, consider now the following data:
   - signal bandwidth ≈100Hz
   - metal body material: Steel (Young modulus: $22*10^4 N/mm^2$)
   - metal body section: $3x12mm^2$

   If we want to measure a force of 10N with a **minimum SNR equal to 10**, what is the maximum wideband noise that the read-out preamplifier can have? Discuss the solution and express the result only in terms of S_V, equivalent voltage noise generator referred to the preamplifier input, i.e. consider S_I negligible.

C) Consider now that the preamplifier chosen above introduces also a 1/f noise component and that a zero setting can be carried out once an hour. Calculate the maximum corner frequency that can be tolerated to make the contribution of 1/f noise negligible.

D) In the same conditions of point C, discuss if and how the measurement could be improved by modulating the signal with a square wave. Report **quantitatively** the values of signal and noise and describe how these values are obtained.