02/02/2024 – solution draft

Pb1)

A) The signal is superimposed to an undesired baseline which must be removed. Exploiting the sync, samples on positive and negative peaks of the sinusoidal signal can be acquired and subtracted with a twofold advantage: the signal is doubled (with respect to a single acquisition) and the baseline is removed. The signal can be acquired for 1s providing an exponentially decreasing weight to rely more on the most recent information. $V_{P,MIN} = \frac{1}{2}\sqrt{S_V \frac{\pi}{2} f_A \frac{T_S}{\tau}} = 14\mu V$.

B) The best filtering scheme consists of a LIA: by multiplying the baseline and the signal by the reference, the signal is shifted to DC and it can be recovered with a LPF. The bandwidth of the signal is around 0.8Hz. Therefore, a suitable f_{PLPF} is 10HZ. In this case, $V_{P,MIN} = \sqrt{2S_V \frac{\pi}{2} f_{P,LPF}} = 56nV$.

C) See theory.

Pb2)

A) Four strain gauges are necessary to acquire the signal while filtering out any temperature- or bending-induced component. Exploiting the available sync, the best filter on the single pulse is a gated integrator. The minimum strain that could be measured with this solution is $12.4\ 10^{-3}$ microstrain, corresponding to F_{MIN}=3.35N.

B) To avoid 1/f noise the constant bias is replaced with a square wave (+/-V_A), fmod=10kHz. Demodulation brings the signal back to its initial characteristics (square wave). A ratemeter or a boxcar integrator provide the best possible filtering option leading to a minimum measurable strain as low as $0.88\ 10^{-3}$ microstrain and F_{MIN}=0.24N.

C) See theory.