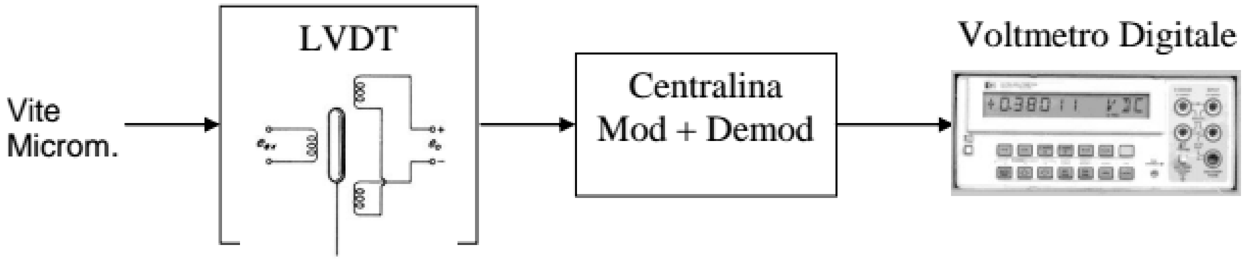
THERMOMECHANICAL MEASUREMENTS FOR ENERGY SYSTEMS

MENR (A.A. 2017-2018)

Laboratory n. 4

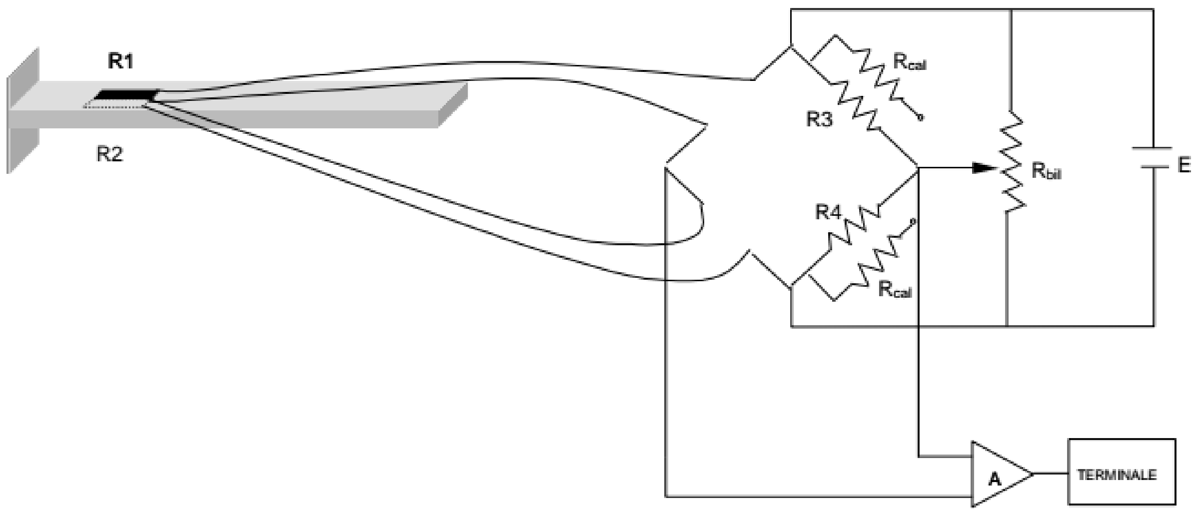
1) A measurement chain is made up as follows: a ***linear variable differential transformer*** (LVDT), a *signal condition unit* supplied by the grid, a *digital voltmeter*. The signal conditioning unit also supplies the primary coiling of the LVDT with a frequency f_p of about $8.3kHz$ and it amplifies (with variable gain) the voltage outputted from the secondary coiling. The inner ferromagnetic core has a mass of $7.6g$ while the non-magnetic connecting rod has a mass of $11.7g$.



By using a micrometer screw (Palmer):

- Trace the calibration curve of the LVDT.
- Define the measurement span that might be considered linear, estimating the maximum non-linearity error value inside the span.
- Calculate the sensitivity of the instrument.
- Using a digital oscilloscope, analyze the response of the two coils that make up the secondary circuit of LVDT by changing the position of the transformer core.
- Estimate the bandwidth of the device, indicating a plausible cut-off frequency.

2) Two identical strain gauges are applied on a clamped beam ($section = 30 \times 4\ mm^2$) at $200mm$ from the free end, one on the upper surface and the other on the lower surface. The two strain gauges have a base resistance of $R_1 = R_2 = 120\Omega$ and a calibration factor $F = 2$. A *strain gauge control unit* complete the Wheatstone bridge with two equal resistors $R_3 = R_4 = 350\Omega$ and supplies it with a voltage E not exceeding $2V$.



- Balance the bridge when the beam is unloaded .
- After connecting the control unit to a digital voltmeter, calibrate the *strain channel* by inserting in parallel both R_3 and R_4 (a calibration resistance R_{cal}=175$k\Omega$). Calculate the strain simulated by the calibration $\varepsilon_{cal} = \pm\frac{R_3}{R_3+R_{cal}} \cdot \frac{1}{FA}$ (A = bridge factor), then change the amplifier gain to obtain an appropriate value for the sensitivity of the strain gauge channel (for example $\frac{1mV}{\mu mm^{-1}}$).
- Apply to the free end of the beam different loads of known mass ($1kg$; $2kg$; $5kg$) and find experimentally the deformation in the section where the strain gauges are applied.
- Known the stress $\sigma = \frac{M_f}{W}$, calculate the Young module E and compare the value obtained with the theoretical one ($E = 200GPa \pm 10GPa$).