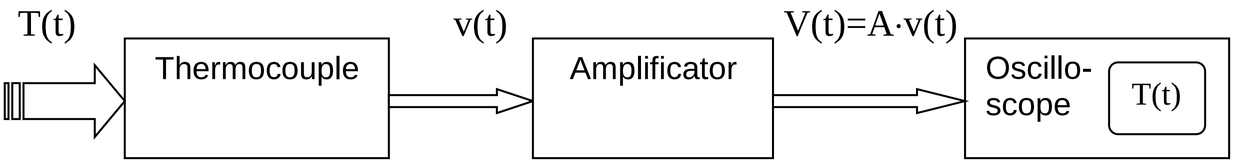
THERMOMECHANICAL MEASUREMENTS FOR ENERGY SYSTEMS

MENR (A. A. 2017-2018)

Laboratory n. 1

<u>1st PART</u> :



The measurement chain (electric thermometer) is composed by:

- A Cromel-Alumel thermocouple (sensor) characterized by a linear graduation curve in the measured range of temperature
- Voltage CC amplifier with variable gain A (signal processor)
- Digital oscilloscope which allows to save data via USB (terminal instrument)

1. Define the time constant λ of the thermocouple, giving as input a step temperature signal. The thermocouple output signal is:

   $T - T_f = (T_i - T_f) \cdot e^{-\frac{t}{\lambda}}$ for $T_i > T_f$ and for $T_i < T_f$

   where T_i and T_f are the initial and final temperature, respectively.
2. Do the same in order to define λ both with $T_i > T_f$ and $T_i < T_f$.
3. Explain the differences between the two calculated values of λ.
4. Evaluate the accuracy of λ with the theoretical studied methods for the temperature jump that you think is more appropriated (for $T_f > T_i$ or $T_i > T_f$), according to several measurements of λ done by some students.

2nd PART :

The measurement chain (Beam with strain gauges) is composed by:

- Carbon steel with fixed-end beam, that is characterized by: length l=300mm, width b=30mm and thickness h=4mm. Two resistance strain gauges (sensor) are fixed on the opposite sides of the beam
- Wheatstone bridge with internal amplifier A (signal processor)
- Digital oscilloscope which allows to save data via USB (terminal instrument)

1. Apply, each time, at the free edge of the beam a mass of 1kg, 2kg and 5kg. Define experimentally the characteristic values of the second order system (ω_n and ξ). Do the same in the case of no load applied on the beam.
2. Considering m=2kg, compare the experimental value of resonance frequency ($f_0=\omega_0/2\pi$) with the theoretical one f_n, calculated in the previous laboratory's experience and then discuss about the differences.
3. Evaluate the accuracy of the measurements.

Considering m_1 and m_2, verify the accuracy of the formula: $\frac{f_1}{f_2}=\sqrt{\frac{m_2}{m_1}}$.

Use this formula in order to obtain the mass m_0 of the beam and compare the experimental value of m_0 with the theoretical one.

You might use these formula for the calculations:

$$f=\frac{\omega}{2\pi}=\frac{1}{T} \qquad f_0=f_n\cdot\sqrt{1-\xi^2} \qquad \delta=\ln\frac{A_n}{A_{n+1}}=2\pi\frac{\xi}{\sqrt{1-\xi^2}}$$