Mechanical oscillators between real and virtual

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Our study is developed in the framework of the Comenius “Hand’s on Science” Project. We intended to find the right way to show to our students how the oscillator amplitude depends on time, to calculate the period of oscillation, to study the influence of the medium over the decreasing of the amplitude.

1. **The mathematical pendulum** oscillates with a period that depend only of the length of the wire l, and the gravitational acceleration *g*. The pendulum stops moving because of friction. We used the mathematical pendulum for the calculation of the gravitational acceleration *g*.

$$g=4\pi^2 l/T^2,$$

where T is the oscillation period. So we had to calculate the oscillation period. Our first pendulum had two wires of 1,38m and a magnet which oscillated over an inductor of 35 mH. We have used a data acquisition board NIDAQ 6013 connected to the inductor for the registration of the oscillation (fig. 1).The DAQ-software was developed with LabVIEW.

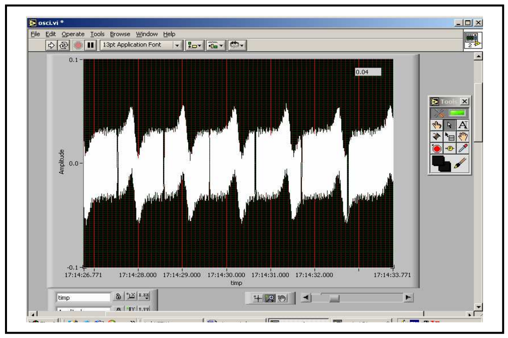
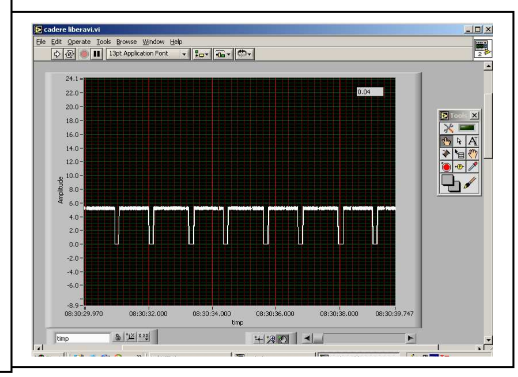


fig 1

fig 2



The second experiment used a photodiode illuminated by a bulb as you can see in the fig. 2. It was also connected to the DAQ board and when the pendulum was in the middle of its cycle the signal falls. So we can measure the oscillation period of the pendulum. The obtained values are shown in the following table.

Sensor	no	T(s)	$T_{av(s)}$	ΔT(s)	g(m/s^2)	g_{av}(m/s^2)
Inductor	1	2,35		0,015	9,89	
	2	2,32	2,335	0,015	10,14	10.01
Photodiode	1	2,36		0,002	9,807	
	2	2,365	2,362	0,003	9,765	9,78

2. **The spring pendulum** oscillates with a period that depend only of elasticity coefficient k and the mass of the body m. The amplitude of it’s oscillations depends on the resistance of the medium, on the friction. We intended to illustrate the oscillating regimes. First we

developed a VI (virtual instrument) for modeling the pendulum amplitude's dependence on time.(fig. 3) The fig. 4 shows the decrease of the amplitude when the amortization coefficient rises. Finally the oscillation became critical.

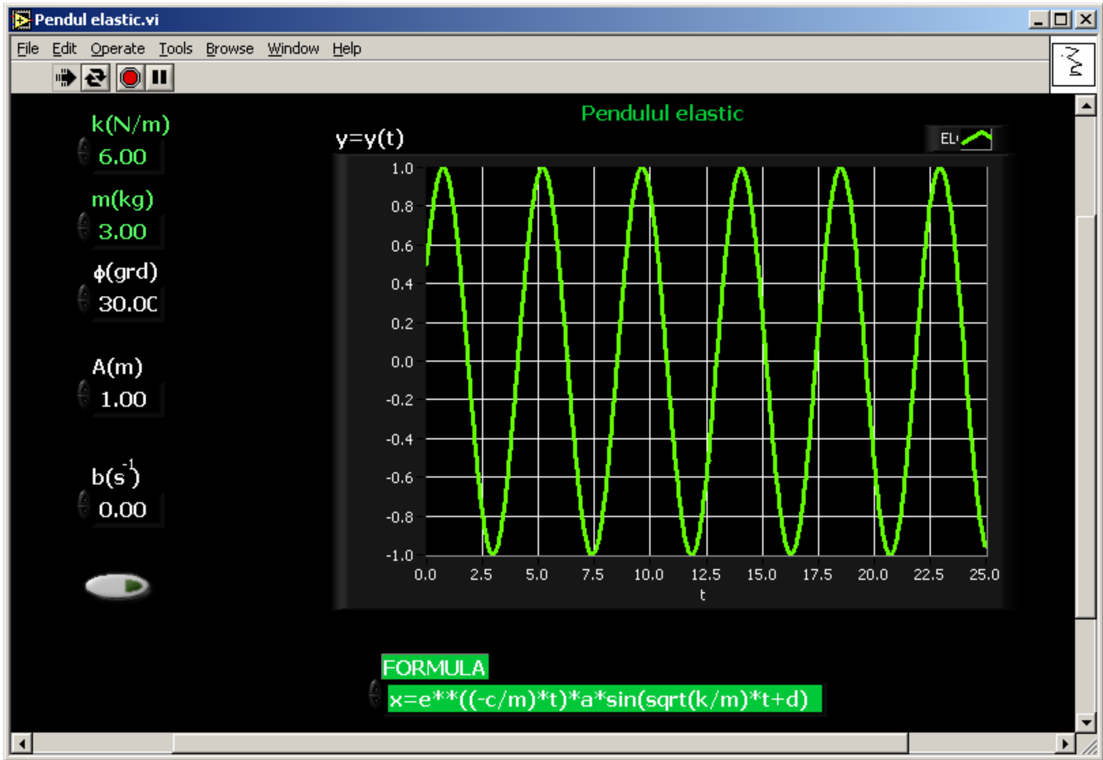


fig 3

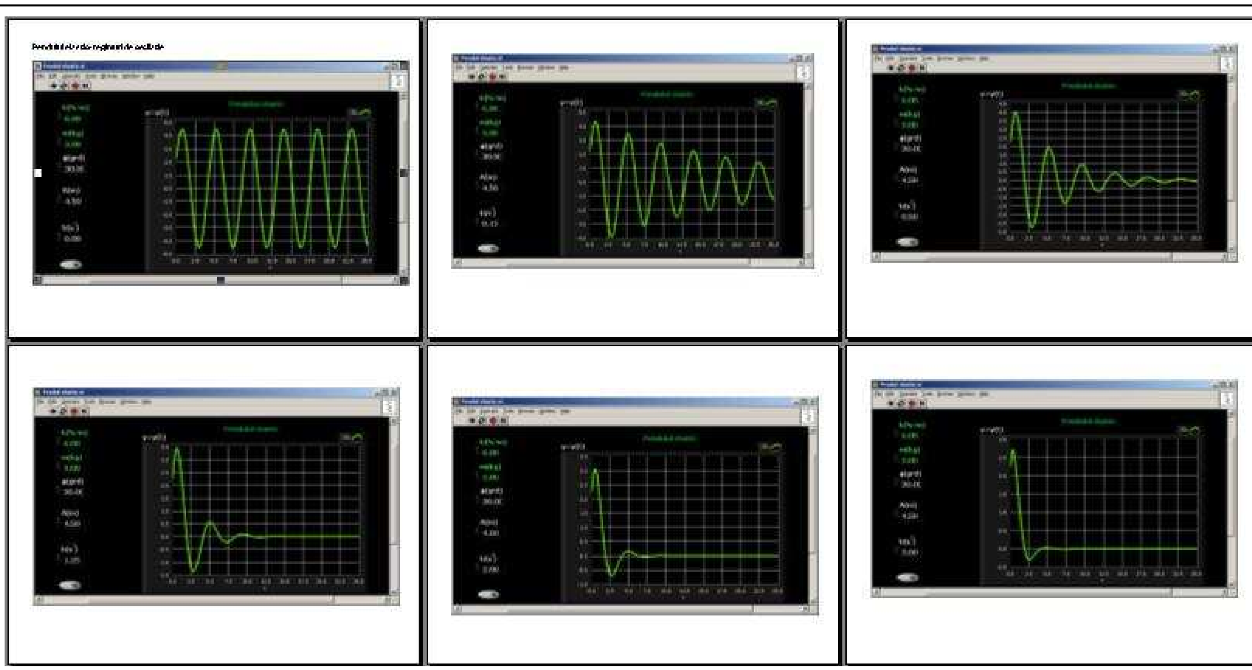


fig 4

fig 5

Knowing how the spring pendulum will oscillate depending on the amortization coefficient b, we take the registration of the real oscillatory movement using data acquisition board NI DAQ 6013 connected to the inductor. The experimental device is shown in the fig. 5. The magnet was suspended on the spring and oscillated in the inductor. The electromagnetic induction appeared and the difference of potential from the inductor oscillated in the same way as the pendulum. We have changed the resistance of the medium by introducing the magnet into a recipient with a solution of honey and water with different concentrations. The DAQ-software was developed with LabVIEW. The results are shown in the fig. 6. By reading the oscillating period in the air where we can consider the amortization doesn't appear we have calculate the elasticity coefficient k

$$\mathbf{k = 4\pi^2 m/T^2}$$

m= 50g, T=0,55s, so k= 6,51N/m

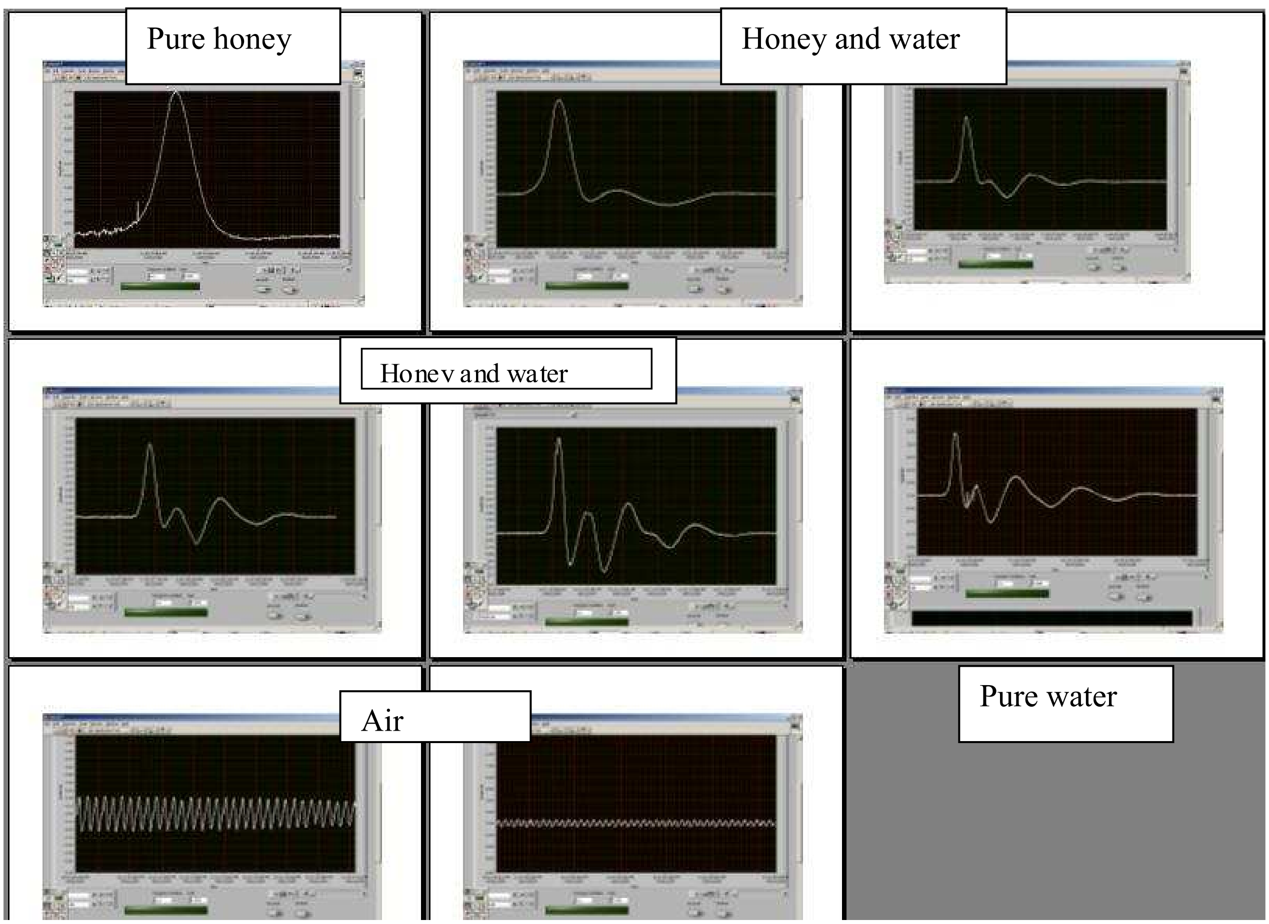


fig.6

Keywords: LabVIEW, DAQ-data acquisition, DAQ-software, VI-virtual instrument, mechanical oscillator, mathematical pendulum, spring pendulum