Lesson №6. Studying of the sensors.

PRACTICAL PART

The aim of the work:

1. To study the physical basics of Tenzo-, thermo - and photosensors.

2. Determine the coefficient of relative strain sensitivity of the load cell.

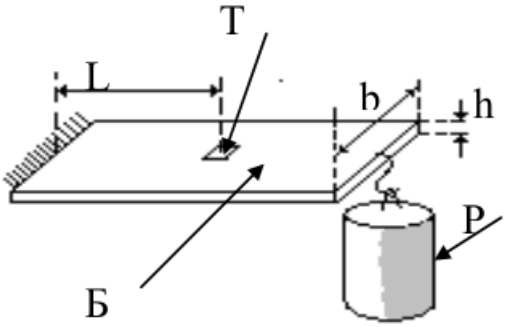
3. Calibrate the thermocouple and determine the value of the thermo-EMF.

4. Determine the relative change in the concentration of oxyhemoglobin in the blood using a photooxyhemometer.

EQUIPMENT: computer, thermocouple, galvanometer, resistance magazine, thermometer, oil vessel, electric heater, magnetic stirrer, photo-oximeter, stopwatch.

Task 1. Determine the sensitivity coefficient of the load cell.

1. The load cell resistance is measured using the Wheatstone bridge, one arm of which is a load cell (B) with a tenzosensor T glued to it, and the other - variable resistance:



The experimental setup with a load cell (T-load cell, Б- beam).

2. Write down the width b, the thickness h of the beam, and the distance L from the beam attachment point to the load cell T. Enter the results in table.

3. With the help of the resistance balance of the bridge, determine the resistance R_0 of the undeformed sensor.

4. Load the load cell with weight P, balance the Wheatstone bridge and determine the resistance R of the deformed sensor.

Repeat the measurements for several P values, and enter the data in table:

№	b, *m*	h, *m*	L, *m*	P, N	R_0, Ohm	ΔR, Ohm	K	$K_{av} \pm \sigma$
1								
2								
3								
4								

5. Calculate the coefficient K of strain sensitivity using the formula

$$K = \frac{\Delta R}{R_0} \cdot \frac{bh^2}{6P} \cdot \frac{E}{L}$$, where:

R_0 - is the resistance of the sensor with no load;

ΔR - change in the resistance of the sensor when it is deformed;

b - width of the load cell;

h - thickness of the load cell;

L - distance from the load cell attachment point to the sensor;

P - weight of the load deforming the load cell;

E-young's modulus (10^{11} N/m^2).

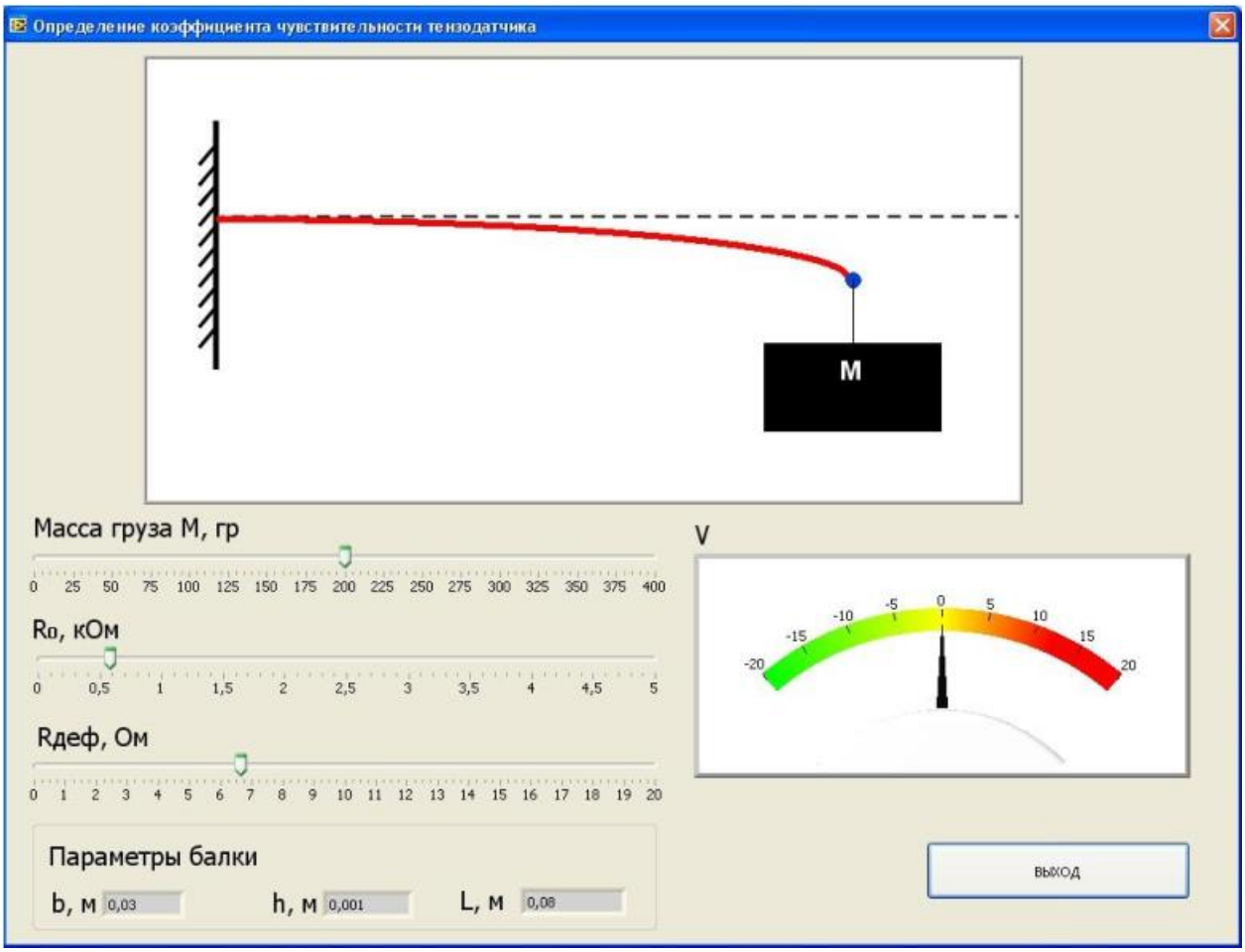


Diagram of a virtual installation with a load cell (The weight of the cargo is indicated in grams, R_0 - in kOhm).

Task 2. To measure the concentration of oxygenated hemoglobin in the blood the man with the help of the oximeter.

The concentration of oxyhemoglobin (depending on the degree of blood oxygen saturation) is determined by light absorption. A photooximeter is an electronic potentiometer that operates from a photo-sensor. A change in the degree of oxygen saturation of the blood causes a change in the blood absorption spectrum. Passing light with a wavelength of 540 nm through the object (corresponding to the absorption line for oxyhemoglobin), the blood content of oxyhemoglobin is estimated from the

light absorption. If you reduce the saturation - oxygen saturation of the blood decreases the content of oxyhemoglobin and increases the intensity of light passing through the object, therefore, the light flux incident on the photo-resistor increases, and its resistance decreases. The potentiometer scale shows the level of hemoglobin in %.

1. With the help of the oximeter to determine the level blood oxygen saturation in a calm state.

2. Examine the dynamics of changes in the hemoglobin content during breath retention. Enter the data in table 4.

3. Investigate the dynamics of recovery of blood oxygen saturation content during respiration recovery.

Time, s	Delay of breath					Recovery of breath				
	10	20	30	40	50	60	70	80	90	100
blood oxygen saturation										

5. Based on the results of the experiment, **draw a graph** of the dependence of blood oxygen saturation on time.

6. Conclude.

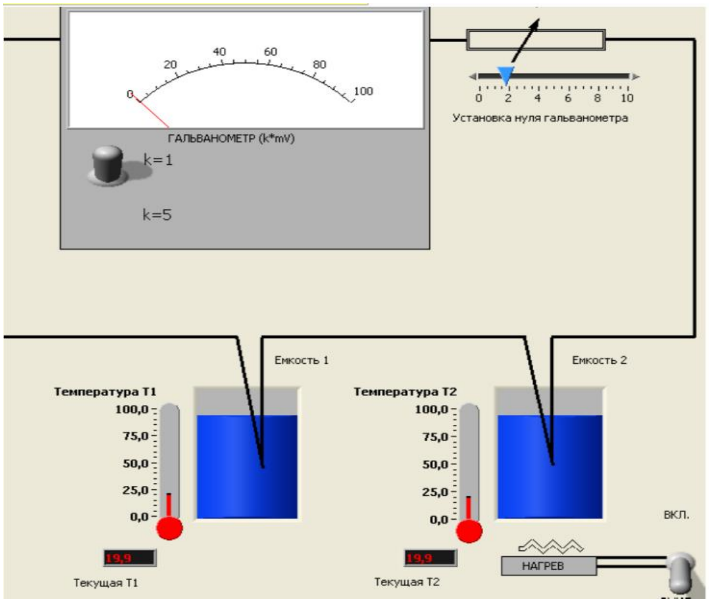
***Task 3. Calibration of the thermocouple (additional task).**

1. Set the galvanometer knob to position K=1.

2. Set the galvanometer to 0.

3. Remove the initial temperature reading T_1 and enter the value in table.

4. Turn on the heating knob and record the galvanometer reading (U_i) every 10^0C. Enter the data in table. Heat up to 90 – 100^0C.



5. Build a calibration graph.

№	T_1 ^0C	T_2 ^0C	ΔT ^0C	U_i, μV
1				
2				
…				
n				

6. Use the calibration schedule to determine the temperature of the sample for the value U set by the teacher.

Control questions on the topic of the lesson.

1. What is called a sensor? Specify the main types of sensors.
2. What is called the sensor sensitivity and the threshold sensitivity?
3. Describe the device and the principle of operation of the load cell, its use in medicine.
4. Explain the device and the principle of operation of thermal sensors.
5. Explain the device and how the photo sensors work.
6. Give examples of the use of sensors in medicine.
7. What are the main advantages of electrical methods for measuring non-electrical quantities?

Situational tasks on a topic

1.The coefficient of strain sensitivity is 6.5. Calculate the value of the relative change in resistance if the young's modulus E= 1013 N / m2, and the strain value is 1012 N / m2.

2. Calculate the sensitivity of the photocell, if a change in the light flux of 20 Lm changes the photo-EMF by 0.01 V.

3. What is the sensitivity coefficient of the photoresistor, if a change in the light flux of 50 Lm changes the sensor resistance by 25 Ohms?

4. the temperature Difference between the junctions of the thermocouple is 100° C, this leads to the appearance of a thermal EMF of 0.1 V. What is the sensitivity coefficient of such a thermocouple?

5. What is the sensitivity coefficient of the thermistor, if the temperature changes by 70° C, the resistance value changed by 280 Ohms?