ELTE EÖTVÖS LORÁND UNIVERSITY

Micro:bit: A Game for Physics Teachers

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HiTech DIY for Physics Teachers optional course-unit:

- Initiator and name giver of the course:

  Dr. Károly Piláth, Eötvös Loránd University, Trefort Ágoston High School.

- At the begining (2017): 1 semester.

- Since 2020: 2 semesters and for physicist students, too.

The objectives of the course are:

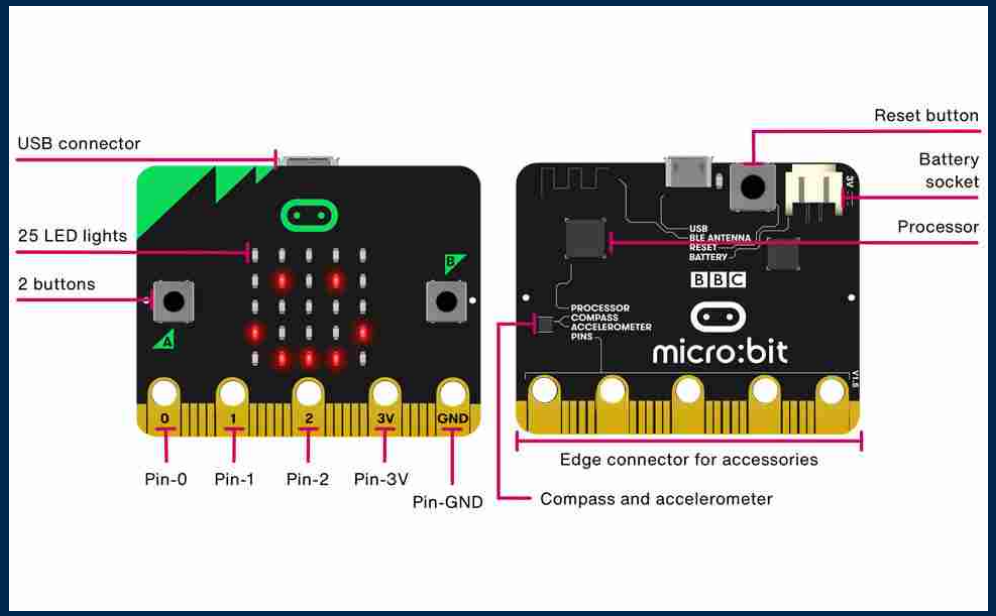
- relief of tension and anxiety,
- provide an introduction to programming,
- develop basic knowledge of electronics, and
- an introduction to 3D printing design,
- soldering of electronic components,

The objectives of the course are:

- designing simple physics measurement circuits with the aid of a computer,
- it allows students to engage in drone programming. Just for fun!

ALL PRESENTED IN A PLAYFUL AND AN ENGAGING WAY!

Equipment used:



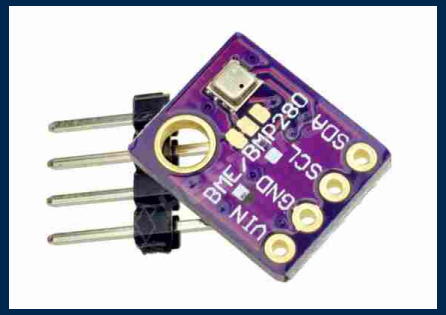
Micro:bit
~ 25 EUR

Elecfreaks Starter Kit
~ 40 EUR

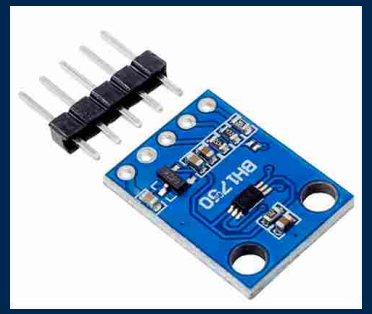
Equipment used:

Ultrasonic sensor (hc-sr04)
~ 3 EUR

Hall sensor (SS49E)
~ 5 EUR



Pressure temperature and humidity sensor (BME280)
~ 3 EUR

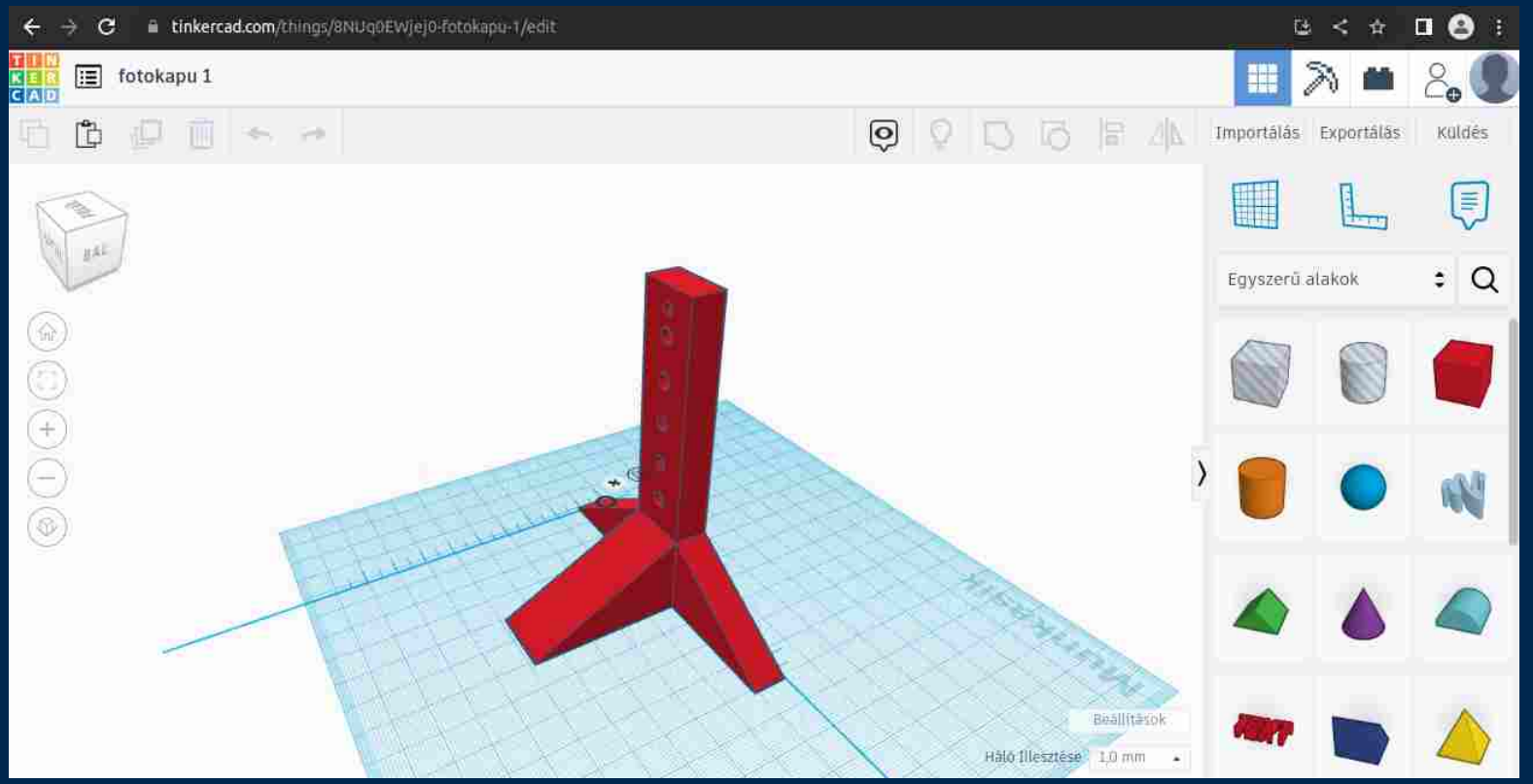


Light sensor (BH1750)
~ 2 EUR

Equipment used:

DJI Tello EDU drone
(these are my own drones)

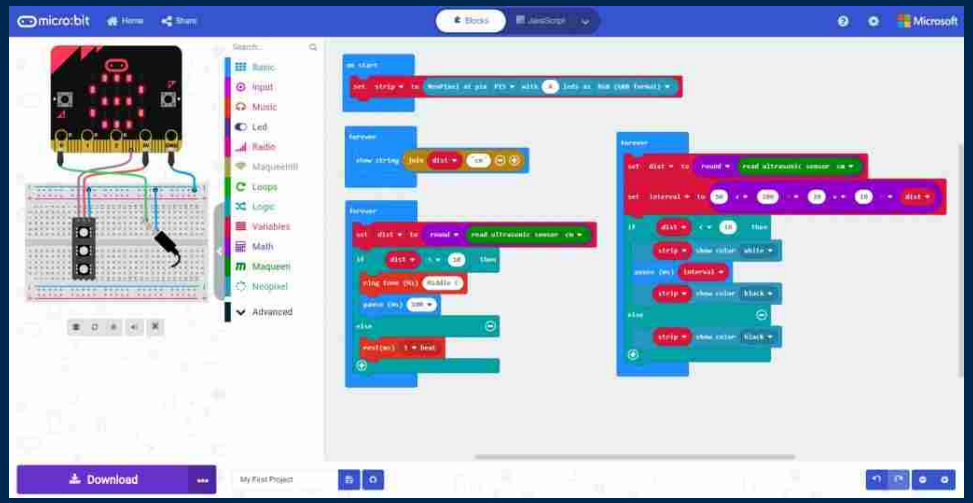
3D printing:



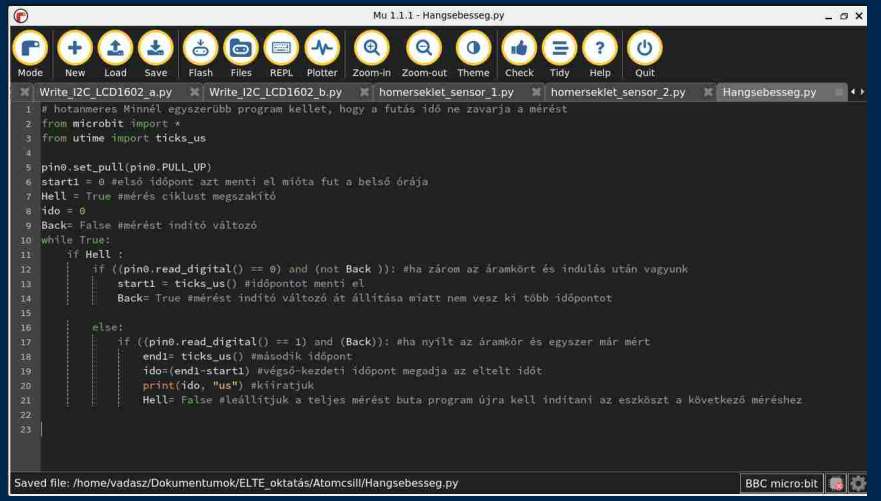
Thinkercad
(www.tinkercad.com)

The course is structured as follows:

- First (autumn) semester: Scratch programming,
- Second (spring) semester: Python programming



Makecode
(makecode.microbit.org)



Mu Editor
(offline editor)

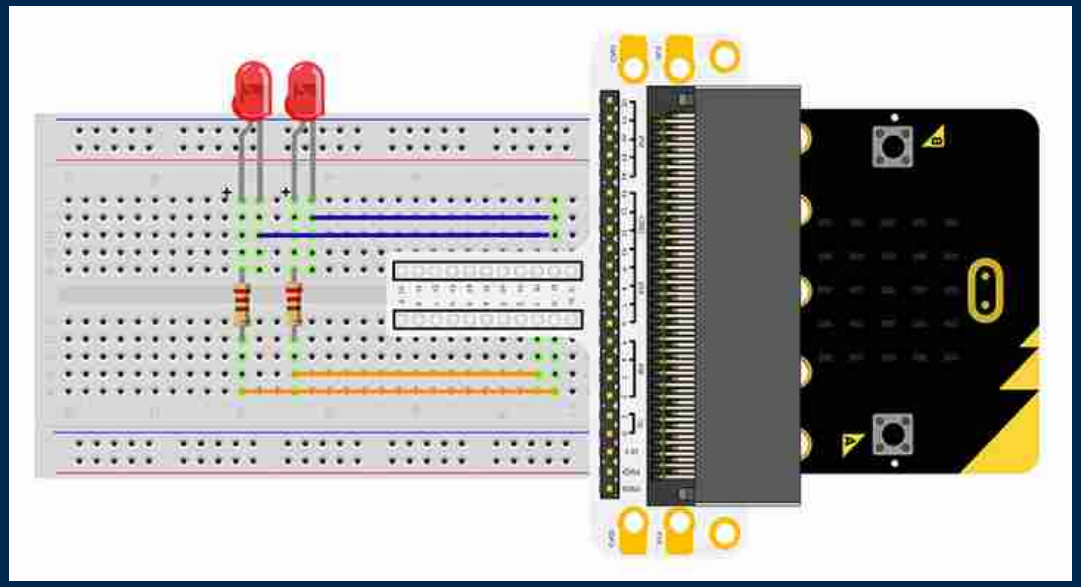
The course is structured as follows:

- In both semesters, we use the same sensors and physics experiments; only the programming language is different.
- Students may choose the semesters independently, according to their previous knowledge.

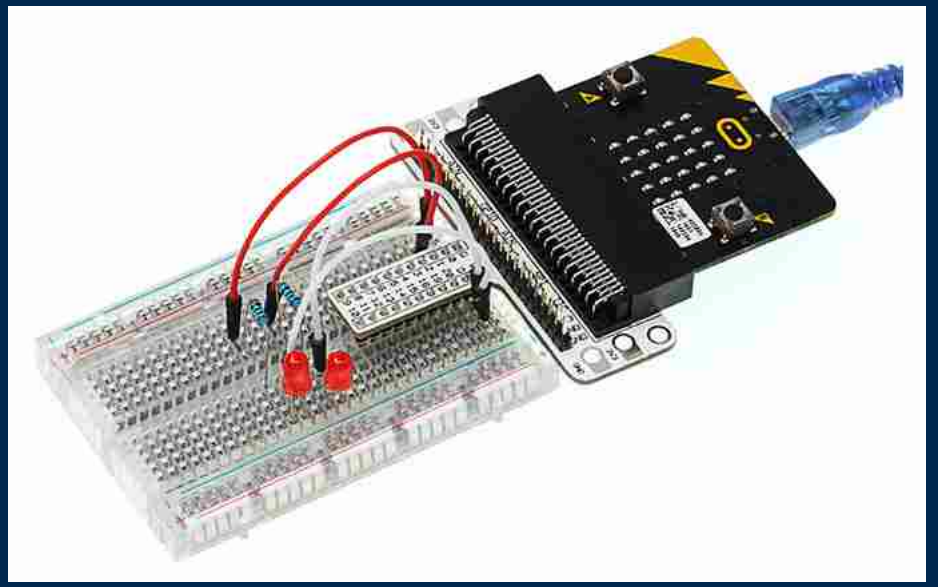
The lessons are structured as follows:

- lesson duration: 90 minutes,
- in the first part of the lesson, students are introduced to the new material (30-45 min.),
- in the second part, during independent activities, they connect the new content with what they have previously learned (45-60 min.),
- they design their own devices, test them, debug them. This is real STEM learning in action.

Wiring LEDs in circuits with Microbit:

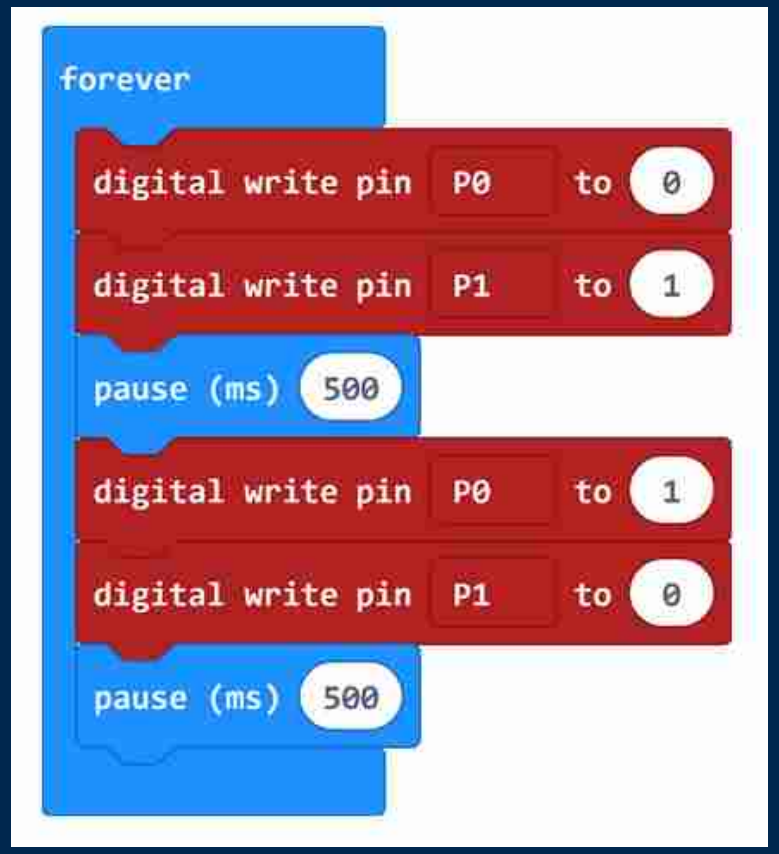


(picture: www.elecfreaks.com)



(picture: www.elecfreaks.com)

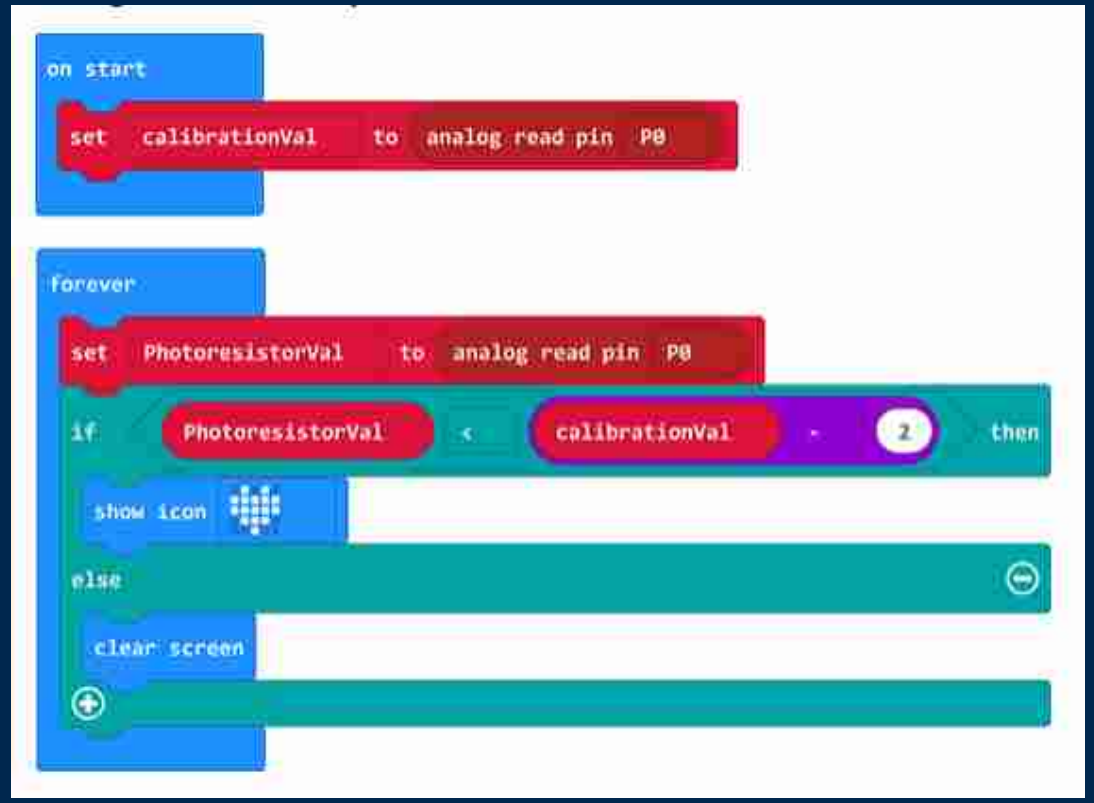
Code for LEDs in circuits with Microbit:



(picture: www.elecfreaks.com)

```
from microbit import *

while True:
    pin0.write_digital(0)
    pin1.write_digital(1)
    sleep(500)
    pin0.write_digital(1)
    pin1.write_digital(0)
    sleep(500)
```

Code for photoresistor:



(picture: www.elecfreaks.com)

```
from microbit import *

CalVal = pin0.read_analog()

while True:
    PhoVal = pin0.read_analog()
    if PhoVal < CalVal-6:
        display.show(Image.HEART)
    else:
        display.clear
```

Requirements for completing the course:

- students are required to design and carry out a physical experiment making use of the material from at least two lessons,
- the experiment must be documented by producing a video recording as well as a written report of one to two pages in length.
- If students have their own ideas, they may implement them after consultation with me, as the instructor.

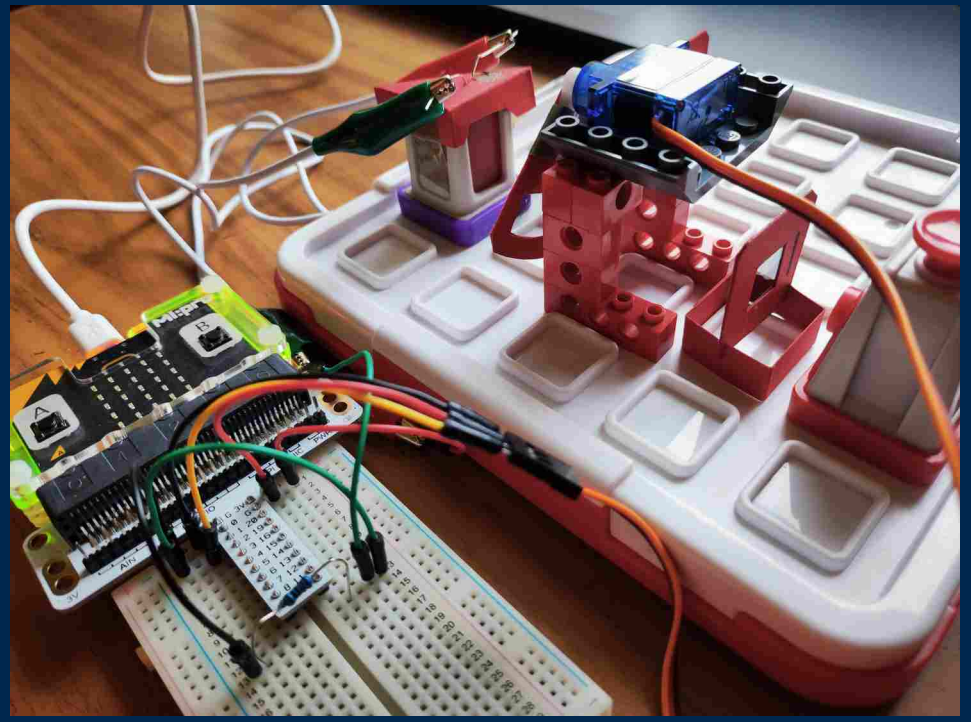
Examples of students' work:

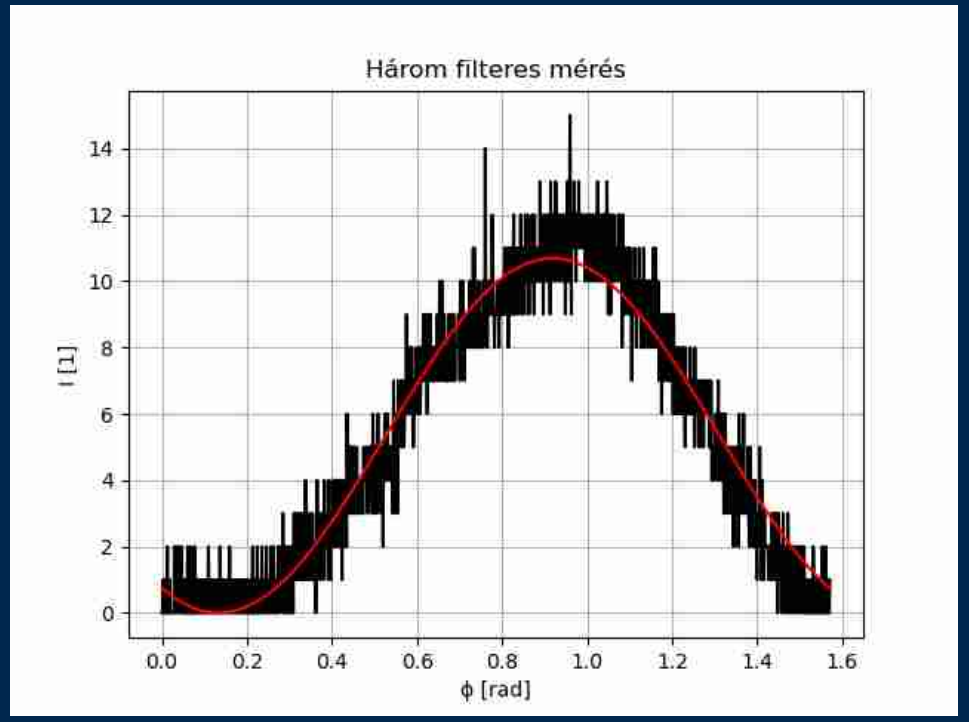
- Szilárd Nagy: Measurement of the propagation velocity of shock waves in solid materials

```
from microbit import *
from utime import ticks_us

pin0.set_pull(pin0.PULL_UP)
start1 = 0 #első időpont azt menti el mióta fut a belső órája
Hell = True #mérés ciklust megszakító
ido = 0
Back= False #mérést indító változó
while True:
    if Hell :
        if ((pin0.read_digital() == 0) and (not Back )): #ha zárom az áramkört és indulás után vagyunk
            start1 = ticks_us() #időpontot menti el
            Back= True #mérést indító változó át állítása miatt nem vesz ki több időpontot

        else:
            if ((pin0.read_digital() == 1) and (Back)): #ha nyílt az áramkör és egyszer már mért
                end1= ticks_us() #második időpont
                ido=(end1-start1) #végső-kezdeti időpont megadja az eltelt időt
                print(ido, "us") #kiiratjuk
                Hell= False #leállítjuk a teljes mérést buta program újra kell indítani az eszközt a következő méréshez
```

Examples of students' work:

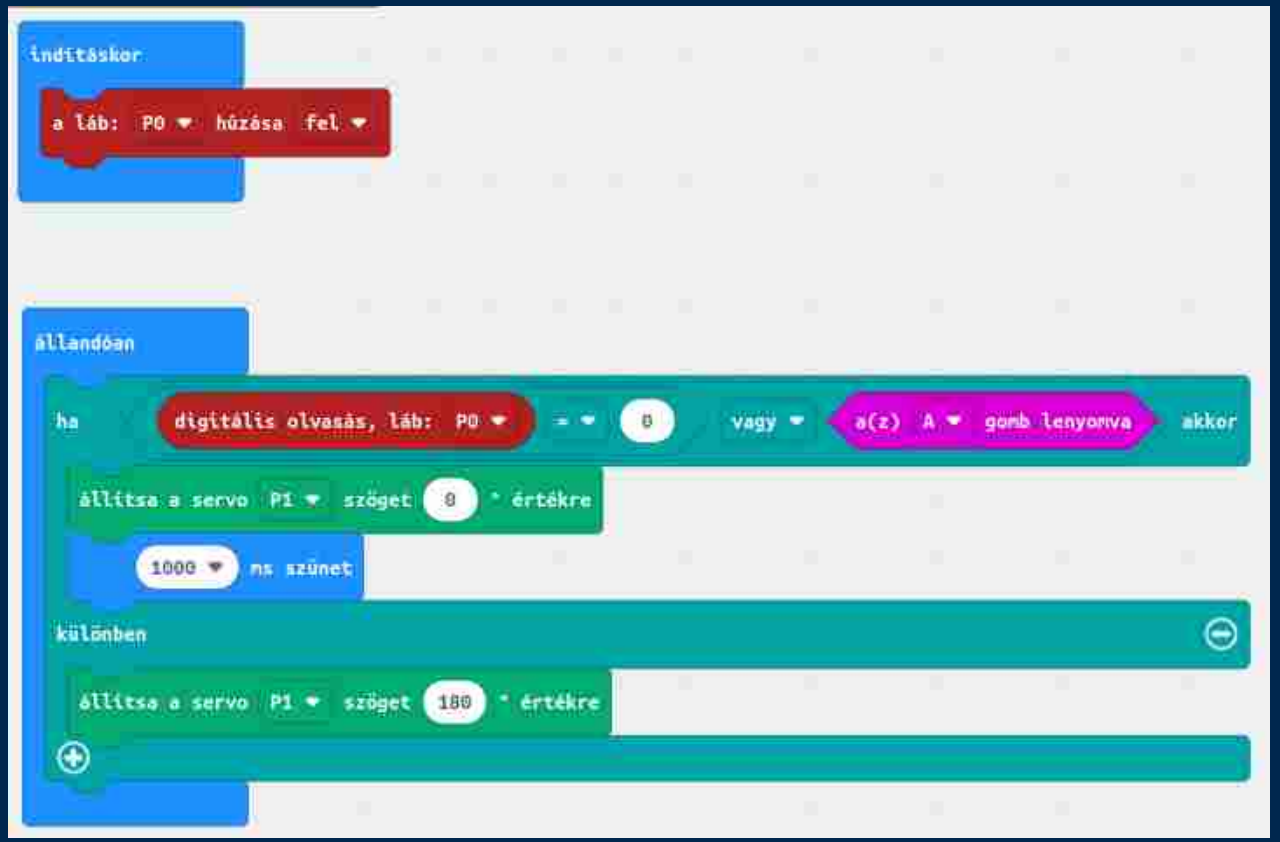
- Márton Erdélyi: Malus's law





Examples of students' work:

- Balázs Fehér: Useless machine

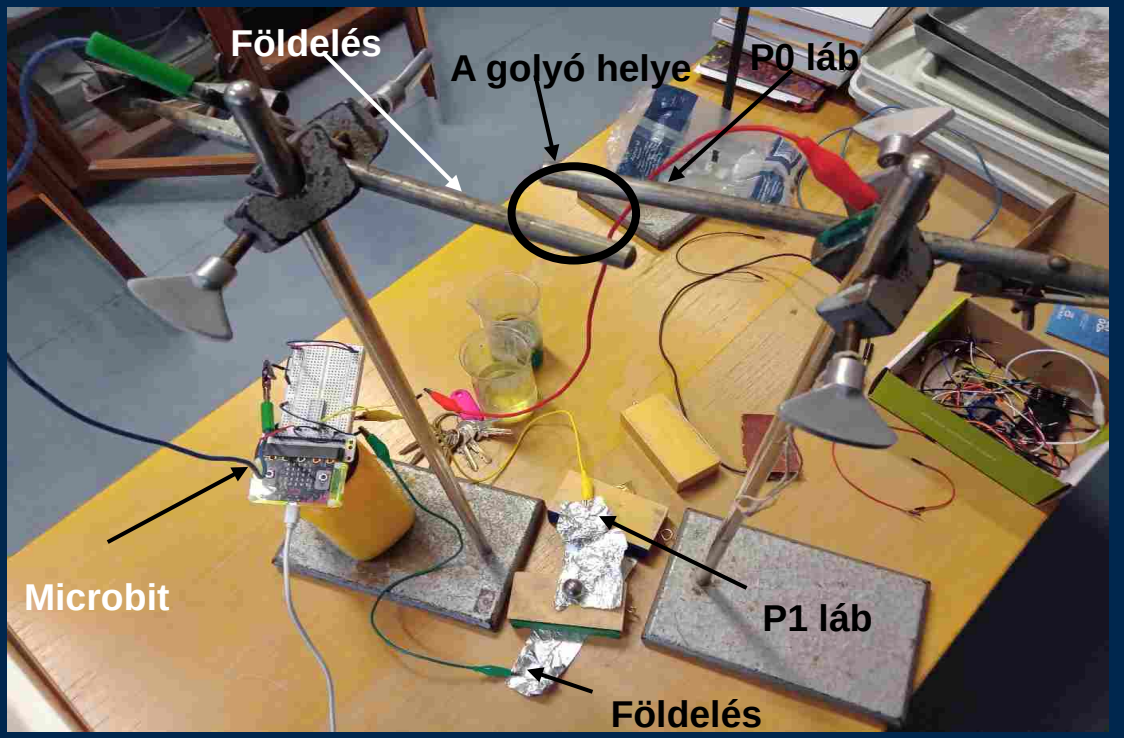


Examples of students' work:

- Eszter Kósa: Building an electronic piano

Examples of students' work:

- Gergely Sándor: Measuring gravitational acceleration (g=8,95 m/s^2)



Examples of students' work:

- Ádam Kadlecsik: Measuring the motion of a university Foucault pendulum with an ultrasonic sensor

```
from microbit import *
from machine import time_pulse_us

trig = pin0 # az ultrahang jelet a Pin 0 küldjük ki
echo = pin1 # a visszavert jelet a Pin 1-en észleljük

trig.write_digital(0)
echo.read_digital()

while True:
    if button_a.is_pressed(): # gyors ellenőrzési lehetőség, hogy fut-e a programunk a microbit-en
        display.show(Image.YES)
        sleep(500)
    else:
        trig.write_digital(1)
        trig.write_digital(0)
        t_micro_s = time_pulse_us(echo, 1) # impulzus visszatérési ideje mikroszekundum egységben,
                                           # az 1 azt jelenti, hogy a mérés a HIGH jelre indul és a LOW-ra jelre megáll.
                                           # A 0 esetén fordítva LOW-ra indul és HIGH-ra megáll
        t_echo = t_micro_s / 1000000 # mikroszekundumból másodperc
        # hangsebesség kiszámítása c = (331.5 + 0.6*T) [m/s], ahol T a hőmérséklet Celsius fokban és -20°C < T < +40°C
        dist_cm = t_echo * 34000 / 2 # hangsebesség 19°C-on kb. 340 m/s = 34000 cm/s; /2 mert odo-vissza megy a jel
        print((dist_cm,))
        sleep(100)
```