



CURRICULUM

IO2 – Basics of STEM education Online Training Course

The general function fulfilled by STEM education is to integrate theoretical and applied knowledge from the natural sciences, technology, engineering, and mathematics. This present curriculum describes the topics addressed by the IO2 – Basics of STEM education Online Training Course, a basic/introductory online training module of STEM (Science, Technology, Engineering, and Mathematics) for youth. This training module focuses on the following basic topics corresponding to STEM education:

1. Physics: Electricity, Optics, Mechanics, Thermodynamics (Science);
2. Elementary Programming and Core Technology Tools (Technology);
3. Core Electronics elements (Engineering);
4. Applied Math/Arithmetic (Mathematics).

This product takes into account basic aspects from the 4-dimension-world of STEM and is based on the use of an open-source electronic prototyping platform: ARDUINO. The entire course consists of 25 lessons which can be explored in 32-35 hours.

The main areas of competences/skills we centered on the learning content of this specific product are these:

- Analysis skills & Feedback taken from outside;
- Rational judgement;
- Decoding and Interpretation skills;
- Reasoning;
- Deduction;
- Argumentation;
- Use of visual interfacing;
- Handling & manipulation of objects;
- Coordination & construction skills.

TOPICS

1. Turning ON an LED

Project idea: Illuminating an LED based on a program written in Arduino and using circuits elements.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 LED, 1 resistor with a resistance of 220 Ω , jumper wires.

Aspects to be addressed:

- the presentation of the Arduino board;
- the presentation of the breadboard;
- working tools – circuits elements;
- elements of the Arduino window;
- the circuit diagram.

2. Traffic Light

Project idea: The alternate lighting of three LEDs resembling a traffic light based on a program written in Arduino using circuit elements.

Circuit elements needed: Arduino Uno R3 board, breadboard, 3 LEDs (red, yellow, blue), 3 resistors with a resistance of 220 Ω , jumper wires.

Aspects to be addressed:

- using the pins on the Arduino board;
- working tools – circuits elements;
- methods of placing circuit elements on the breadboard;
- the circuit diagram.

3. A pulsating LED

Project idea: Visualizing the variable PWM (Pulse Width Modulation) signal between 0V and 5V using an LED.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 LED, 1 resistor with a resistance of 220 Ω , jumper wires.

Aspects to be addressed:

- using the ports on the Arduino Uno board that support PWM signals;
- using functions that use values between 0 and 255 for the duty cycle of the PWM signal;
- describing the repetitive structure with a known number of steps (with a counter);
- the circuit diagram.

4. Three LEDs controlled by a button

Project idea: The LEDs light up upon pressing a button.

Circuit elements needed: Arduino Uno R3 board, breadboard, 3 LEDs (red, yellow, blue), 3 resistors with a resistance of $220\ \Omega$, 1 button, jumper wires.

Aspects to be addressed:

- introducing the button as a circuit element; its role.
- positioning the button on the breadboard;
- methods of placing circuit elements on the breadboard;
- the circuit diagram.

5. Multicolor LED (RGB LED)

Project idea: Highlighting the PWM signal using an RGB sensor.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 RGB sensor, 3 resistors with a resistance of $220\ \Omega$, jumper wires.

Aspects to be addressed:

- the role of the RGB sensor;
- using the pins on the Arduino board that support PWM signals;
- utilizing color codes;
- the circuit diagram.

6. LED Illumination with a Potentiometer

Project idea: Illuminating an LED using the circuit element potentiometer, an element that allows variation of voltage in a circuit.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 potentiometer, 1 resistor with a resistance of $220\ \Omega$, jumper wires.

Aspects to be addressed:

- the role of the potentiometer in the circuit;
- using the analog pins on the Arduino board;
- ASCII code - displaying data in ASCII code format;
- the circuit diagram.

7. Photoresistor (LDR)

Project idea: Highlighting the dependency of the resistor's (photoresistor) resistance on the amount of light falling on its surface.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 photoresistor (LDR), 1 resistor with a resistance of 10k Ω , jumper wires.

Aspects to be addressed:

- the role of the photoresistor in the circuit;
- using the pins on the Arduino board;
- the circuit diagram.

8. LED with Photoresistor

Project idea: Using an LED and a photoresistor. Employing a function that performs a proportional value transfer from one range (400 - 1023 for the photoresistor) to another range (0 - 255 for the LED).

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 photoresistor (LDR), 1 LED, 1 resistor with a resistance of 10k Ω , 1 resistor with a resistance of 220 Ω , jumper wires.

Aspects to be addressed:

- the role of the photoresistor, LED, and resistors in the circuit;
- using the analog pins on the Arduino board;
- implementing in the program the function that performs value transfer from one range to another;
- the circuit diagram.

9. Temperature Sensor

Project idea: Measuring the temperature using an analog temperature sensor.

Circuit elements needed: : Arduino Uno R3 board, breadboard, 1 temperature sensor, jumper wires.

Aspects to be addressed:

- the role of the temperature sensor in the circuit;
- the instruments for temperature measurement;
- the Analog-to-Digital Converter (ADC) on the Arduino board;
- the Analog-to-digital conversion (ADC);
- the circuit diagram.

10. Buzzer

Project idea: Using an active buzzer (speaker) in a circuit with the Arduino Uno board.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 active buzzer, jumper wires.

Aspects to be addressed:

- the role of the buzzer in the circuit;
- using the pins on the Arduino Uno board;
- the circuit diagram.

11. Buzzer with Button

Project idea: Generating tones between 1.5 and 2.5 kHz. Producing a wide range of sounds.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 passive buzzer, 1 button, 1 resistor with a resistance of 10k Ω , jumper wires.

Aspects to be addressed:

- the role of the passive buzzer in the circuit;
- using the pins on the board to establish connections with the buzzer;
- the circuit diagram.

12. Alarm (Passive Buzzer with LED and Photoresistor)

Project idea: Creating an alarm using a passive buzzer.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 passive buzzer, 1 resistor with a resistance of 10k Ω , 1 resistor with a resistance of 220 Ω , 1 LED, jumper wires.

Aspects to be addressed:

- the role of the circuit elements;
- using the pins on the Arduino Uno board to establish connections;
- the circuit diagram.

13. Tilt Sensor

Project idea: Alerting through sound and visual signals in case the horizontal surface experiences tilt.

Circuit elements needed: Arduino Uno R3 board, breadboard, 1 passive buzzer, 1 resistor with a resistance of $10k\ \Omega$, 1 resistor with a resistance of $220\ \Omega$, 1 LED, 1 tilt sensor, jumper wires.

Aspects to be addressed:

- the role of the tilt sensor in the circuit;
- choosing the pins on the Arduino Uno board to establish connections with the circuits elements;
- the circuit diagram.

14. Ultrasonic Sensor

Project idea: Measuring the distance to an object using an ultrasonic sensor.

Circuit elements needed: Arduino Uno R3 board, breadboard, ultrasonic sensor, jumper wires.

Aspects to be addressed:

- the role of the ultrasonic sensor in the circuit;
- pins on the Arduino Uno board used to establish connections with the sensor;
- the circuit diagram.

15. Display on 7 Segments

Project idea: Using a device that displays numbers and letters composed of 7 LEDs connected in parallel.

Circuit elements needed: Arduino Uno R3 board, breadboard, display device, 8 resistors with a resistance of $220\ \Omega$, jumper wires.

Aspects to be addressed:

- the role of the device in the circuit;
- choosing the pins on the Arduino Uno board used to establish connections with the device;
- the circuit diagram.