Series title: Microcontrollers

Age of participants: 11+

Maximum number of participants per group: 12

Number of hours: 9

Type of track: STEAM, programming

Brief description of the workshop series:
Create your first electronic circuit from scratch using Arduino and learn how to program it to do exactly what you want!
During the workshop, students will learn how to use one of the easiest tools for working with creating and programming electronic circuits - Tinkercad Circuits. From a handful of theories about electricity and its properties, to creating simple circuits in Tinkercad, to building advanced devices - all this to not only know how modern electronic devices work, but most importantly - to be able to create them themselves. Students will use the knowledge they gain to create more projects - the Tinkercad program runs in a browser and is fully free.

What does the workshop teach?
- what electricity is and how to understand its basic properties
- using the computer and its capabilities to build electronic circuits and perform basic electrical simulations
- the ability to navigate in a block programming environment
- the basics of operating input/input and output/output devices
- basics of electrical and electronic circuit construction
- operation of measurement tools (multimeter)
- knowledge of construction and programming of physical devices based on the Arduino platform
- what are algorithms and variables, and how to use in programming?

What skills does the workshop develop?
- advanced operation of the computer with the operation of input and output devices
- knowledge of electricity and its properties

In addition, the classes develop:
- creativity
- algorithmic observation and perception of the world
- teamwork
- engineering thinking

- sense of self-efficacy

Success criteria:

- the student knows what electricity (including electric current) is and can give some examples of current
- the student understands what the current and voltage of electric current are
- student understands how to calculate and read the current consumption of a device, understands what power is
- student knows the basic principles of operation and work with the Arduino platform
- student knows what microcontrollers are currently used for in industry and everyday life
- student knows the basic principles related to the correct and safe operation of multimeters
- student knows the difference between an electrical device and an electronic device
- student knows the difference between a digital device and an analog device
- student understands what an algorithm is and knows how to put the knowledge into practice by referring to everyday phenomena
- learner understands the terms: input/input device, output/output device, variable, constant, serial port monitor, loop, resistance.
- the student understands what is and knows the principle of operation of the following devices: resistor, jumper wire, contact plate, LED, photoresistor, distance sensor, buzzer, servo.
- The student is able to independently log into the Autodesk Tinkercad program
- the student knows the basic functions related to the correct and effective navigation of the program: creating a new project, changing the name of the project, starting a simulation, creating code
- the learner is able to independently create a project in Autodesk Tinkercad using the following functions: adding and correctly connecting elements to each other in the work area, creating electrical connections - wire creation tool, changing the color of wires, creating code, running simulations, analyzing simple errors and solving them.
- the student can read simple electrical diagrams
- the student knows how to continue working in Autodesk Tinkercad after the workshop is over
- the student is able to build a real electronic circuit based on the digital equivalent created in Tinkercad.
- the student knows what the Arduino IDE program is and is able to upload the prepared program to the Arduino platform with its help.

Meeting 1

Duration: 3h

Description.
It's time to take matters into our own hands - we start an adventure in the world of programming and electronics! We will learn a free, browser-based program for creating circuits, programming and performing advanced electrical simulations - Autodesk Tinkercad, Circuits module. We will start our adventure with the world of electronics with what is most important in electricity and electronics - electricity. We will learn the basic modules necessary to conduct the first circuit simulations in the online environment. And these will be: Arduino, LEDs, power sources, resistors and other basic electronic components. It's going to happen!

15 min
Welcoming people attending the workshop, ice breaking, introducing the topic of the class.
It is worth at this stage to jointly work out the rules of cooperation during the entire cycle of the workshop - the so-called contract. Such an action will allow us to give proficiency to participants at the beginning of the workshop, as well as learn about motivations and improve communication

30 min
Story of electricity.
The educator presents the following content in the form of an interactive lecture, while encouraging those attending the workshop to actively engage in the discussion.
(It is a good idea in this part of the workshop to use comparisons to more obvious and understandable phenomena, e.g. a faucet, a river dam, car traffic, etc.).

Links to content that you may find useful when conducting the workshop:
https://www.youtube.com/watch?v=n93QcT-FZI8
https://www.youtube.com/watch?v=VAsVwDqp89Y

1. what is current (in general, e.g., river current, air current, what does it mean to go against the current)?
2. what is electric current?
3. where does current come from?
4. voltage.
5. current intensity.
6. direct current and alternating current.
7. Why do we need phone/tablet/laptop chargers?
8. what is the power of a device?
9. how to count units of power?

In this part of the workshop it is a good idea to use comparisons to more obvious and understandable phenomena, e.g. a faucet, a river dam, car traffic, etc.

15 min
Break

45 min
Working with Tinkercad software. People participating in the workshop take their seats at the previously prepared computer stations.
(The computers should have a web browser installed, preferably updated to the latest version, preferably an application that runs on browsers based on the chromium engine. In addition, to increase the convenience of working with the program, it would be good to equip the participants_ women of the workshop with computer mice)
Educator presents and explains the following content step by step.
Those participating in the workshop repeat the steps. Educator makes sure that everyone understands the issues discussed, encourages questions. You can use here from classroom activities, about which you can learn more here:
https://www.youtube.com/watch?v=DsfdgKeaIR0

1. Logging into Tinkercad and discussing the working environment
2. Introducing the modules and the first schematic (battery + light bulb)
3. On why + and - matter and why.
4. First simulation.
5. What is the difference between an electrical circuit and an electronic circuit?
6. Leds without arduino - connecting an LED to a battery using a suitable resistor
7. Resistors - what they are and what they are for, color coding, resistance selection (counting resistors by color)
   http://kalkulator.majsterkowicza.pl/oblicz/rezystor_do_LED

15 min
Break
It is mandatory for those participating in the workshop to leave the computer stations.

45 min
Working with the program.
Educator presents and explains the following content step by step.
Persons participating in the workshop repeat the activities. Educator makes sure that everyone understands the issues discussed, encourages questions. It is important to take small steps and ask a lot of questions and make sure that the tasks performed are correctly understood.

1. Arduino - what is it, how was it created, why should it be used?
2. Arduino - a brief analysis of connectors
3. Code tab in Tinkercad: discussion of the building blocks that make up the initial code. Discussion of program principles: loop, start, high state, low state, etc.

4. Built-in LED - flashing LED.
5. Simulation in Tinkercad software.
6. Arduino IDE - what is this program, what can this program be used for, brief discussion of UI, selection of ports and board, uploading files to Arduino.
7. Task: We will program the physical Arduino so that the led lights up for 2 seconds and then goes off for 0.5 seconds.

15 min
Brief summary of the work and the workshop day.
Each person has about a minute to show their work and describe how the task went from their perspective.
Evaluation - final round
People participating in the workshop list 1 thing that they liked the most in the class. The educator encourages everyone to speak up.

Homework: In Tinkercad, let's create a program so that the Arduino's built-in LED: lights up three times for a second and goes off for 300ms, after which it should remain off for 5 seconds.

Homework is not mandatory, but it allows participants to consolidate the acquired knowledge.
Putting the workshop room in order.

Meeting 2

Duration: 3h

Description.
Day two will continue working in the Circuits module in Tinkercad. But now we'll go a few steps further: we'll learn what input/input devices, output/output devices or a serial port are. We will learn about the proximity sensor. All this in a beginner-friendly block programming environment.
Get ready for a good dose of new knowledge!

5 min
Welcoming those attending the workshop. Introduce the topic and agenda.
Participants take a seat at the previously prepared workstations.
(Computers should have a web browser installed, preferably updated to the latest version, preferably an application that runs on browsers based on the chromium engine. In addition, to increase the convenience of working with the program, it would be good to equip the participants_women of the workshop with computer mice)

40 min
Working with the program. The educator presents and explains the following content step by step.
People participating in the workshop repeat the steps. Educator makes sure that everyone understands the content discussed.

1. Checking homework and answering participants' questions about the previous activities. It is always a good idea to appreciate the people who did the task and ask the others if the reason for not doing the task was that they did not understand the topic. Answer as many questions about the assignment as possible.
2. Digital pins - inputs and outputs (button, explaining the need for a reference circuit, pull-up, pull-down, flashing LED when the button is pressed)

15 min
Break
Persons participating in the workshop compulsorily leave the computer stations.

45 min
Working with the program. Educator presents and explains the following content step by step.
Persons participating in the workshop repeat the activities. Educator makes sure that everyone understands the content discussed.

1. Proximity sensor as input/input device - what is it and how does it work?
2. Proximity sensor - how to connect it to Arduino? (It is worth noting here what kind of sensor you physically have because they may differ in pins, number of pins and their location).
3. It is good to show at this point how to approach such an issue independently. For this purpose, let's use an Internet search engine, in which we should try to find a wiring diagram. Then let's show how to read such a schematic diagram and reproduce the correct connection of the circuit to the Arduino board with Tinkercad software.

15 min
Break
People participating in the workshop obligatorily leave the computer stations.

50 min
Working with the program. Educator presents and explains the following content step by step. Persons participating in the workshop repeat the activities. Educator makes sure that everyone understands the discussed content.

1. Serial console - what it is and when to use it.
2. Programming the circuit - Arduino together with the distance sensor in Tinkercad.
3. Displaying the distance on the serial console.
4. Conditional function: if(if): explanation of the principle of operation. At this stage, it is good to use a comparison to everyday situations:
5. On pieces of paper, the participants, together with the educator, describe a very simple everyday activity - it is worth asking to be very detailed and not to skip any steps, asking the people at the workshop to think that they are explaining a function to an extraterrestrial being.
6. RESET button in Arduino
7. Task: using the conditional function: if, we will collectively program the Arduino to turn on the built-in LED on the board if the distance from the distance sensor is less than 25cm.
8. Saving the finished project in Tinkercad.

10 min

Brief summary of the work and the workshop day.
Each person has about a minute to show the work and describe how the task went from their perspective.
Evaluation - final round
People participating in the workshop list 1 thing that they liked the most in the class. Educator encourages everyone to speak up.
Homework: In Tinkercad, let's create a program so that the Arduino's built-in LED: lights up three times per second and goes off for 300ms if the distance read by the distance sensor is less than 30cm.

Homework is not mandatory but allows participants to consolidate the acquired knowledge.

Putting the workshop room in order.

Meeting 3

Duration: 3h

Description.
The third meeting is a continuation of work in the Circuits module in Tinkercad. Now, however, there will be no shortage of space to work with the physical Arduino board and sensors and actuators. As always, we will put the knowledge we have gained into practice, and there will be a lot going on!

5 min
Welcoming those attending the workshop. Presentation of the topic and the agenda. Participants take a seat at the previously prepared stands.

40 min
Working with Tinkercad software and a physical Arduino board. The educator presents and explains the following content step by step.
People participating in the workshop repeat the activities. The educator makes sure that everyone understands the content discussed.

1. Checking homework and answering participants' questions about the previous activities.
2. Opening the project saved during the previous classes.
3. Building a physical version of the circuit.
4. Uploading the program to a physical Arduino board - using the Arduino IDE program.
5. Working with the serial console in the Arduino IDE program - reading values from the proximity sensor.

15 min
Break
It is mandatory for those participating in the workshop to leave the computer stations.

45 min
Working with the program and the physical Arduino board. Step-by-step educator presents and explains the following content.
Persons participating in the workshop repeat the activities. The educator makes sure that everyone understands the content discussed.

1. Conditional function: if, else (if, else): what it is, how it differs from the conditional function if, where and when we should use it. It is good to use easy to understand

examples, such as a light switch: if I switch the switch - the light will go on, otherwise it will be turned off.
2. Task: Using the conditional function if, else, let's program the Arduino so that the built LED will turn on when the distance read by the distance sensor is less than 30 cm and turn off when the distance increases.
3. Uploading the program prepared in Tinkercad to the physical Arduino board, testing the program's operation in practice.

15 min
Break
It is mandatory for workshop participants to leave the computer stations.

45 min
Working with the program and the physical Arduino board. Step-by-step educator presents and explains the following content.
Persons participating in the workshop repeat the activities. The educator makes sure that everyone understands the content discussed.

1. Servo - what it is, when and for what it can be used, demonstration of example applications (internet, own previously made projects - robotic arms, writing robots, etc.)
2. Task: how to connect a servo to an Arduino?
3. Create a new project in Tinkercad - save the previous one, we will return to it soon.
4. Programming servos using the Arduino board - in Tinkercad. Setting the appropriate angle of rotation.
5. We return to the previous project - distance sensor.
6. Task: Let's jointly program the Arduino board so that when the value read by the distance sensor is less than 30 cm, the sero will rotate 90 degrees. On the other hand, if the distance is greater than or equal to 30cm, the servo should return to its original position. To do this, we will use the conditional function if, else.
   In this way, we will build a simple barrier simulator.

15 min
Break
It is mandatory for those participating in the workshop to leave the computer stations.

45 min
Working with the program and the physical Arduino board. Step-by-step educator presents and explains the following content.
Persons participating in the workshop repeat the activities. The educator makes sure that everyone understands the content discussed.

1. Task: We build a physical version of the circuit we just created in Tinkercad.
2. Task: Together we will program the circuit so that the servo rotates with the change in distance read by the distance sensor.

15 min
Summary of the workshop day and the entire workshop series.
People participating in the workshop list the 2 things they enjoyed most about all the activities.
Educator encourages everyone to speak up.
The educator encourages to continue the adventure in the world of electronics and programming and to develop the acquired skills and knowledge by creating more projects - the Tinkercad program is freely available and free.
Organizing the workshop room.

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