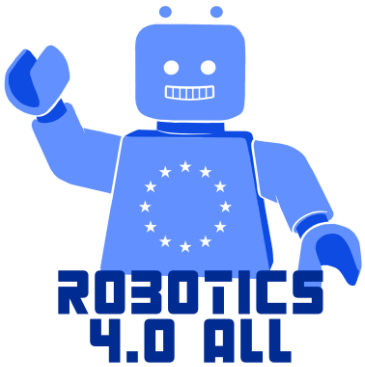
The curriculum plan of the robotics 4.0 all course



Introduction and 21st century skills

Lessons 1-2 (45 min + 45 min)

Introduction/lecture – Fundamentals of robotics
Topics: History of robotics, the use of robots in everyday life, programming, basic terms, acquaintance with the platform being used in practical work, safety rules. Robotic systems: sensor-controller-actuator / lecture and practical work. Sensor-controller-actuator system, microcontroller, its programming, debugging and compiling the program.
Integration: Physics and Mathematics (creating connections), Biology (reference to humans, what are human's controller, sensors and actuators?), Informatics (programming, graphical and text environments for programming, algorithms and their creation).
Learning outcomes: Student is able to describe the following concepts: robot, robotics, manipulator, mechatronics, sensor, actuator, and controller. Student is able to decide whether a robot belongs to the first, second or third generation; describe problems between humans and robots according to I. Asimov's laws; core values, ethics. Student describes the mechatronic system, its components and structure. Student can describe controller's functionality and structure. Students understand 21st century skills.
Real life: Give examples of how technology has been developed throughout the history and how the work of humans has been made easier by beginning with the replacing of humans with robots with regard to routine work in factories and ending with self-driving cars, internet of things. Developing this kind of technology needs good knowledge of Science and Mathematics. Robotic systems exist all around us. Students should describe how a washing machine or other domestic appliances are sensor-controller-actuator systems. For example, the washing machine has a temperature sensor. The controller measures the temperature of the water using this sensor, and a heater is an actuator. In this way, an understanding and recognition of the world and home of robotics will appear.

Output devices (6 lessons)

Lessons 3-6 Actuators

Electric motors / lecture and practical work.
Topics: We learn to recognize various kinds of actuators and the main focus is on electric motors: AC motors, DC motors, servo motors, stepper motors. An overview of alternative actuators (linear motors, solenoids, artificial muscles).
Integration: Mathematics, Physics (electric motors, generators, transmission, friction, inertia, acceleration), Informatics (programming, algorithms).
Learning outcomes: Student is able to describe various electric motors and the differences between them. After completing the chapter, student will be able to choose suitable electric motors, depending on the requirements of their task.
Real life: Are there any engines in a mobile phone? (Yes, if the phone has a vibro alarm) What kind of engines are used in electric cars? Engines are currently the most common way to convert electricity into mechanical energy. Which engines are used in washing machines? (AC and inverter motors)

Lessons 7-8 Feedback

Visual and auditory feedback/ lecture and practical work
Topics: We learn about different visual feedback devices: LED, alphabetic, graphic, etc. We learn about main auditory feedback devices: buzzer and speaker.
Integration: Mathematics (graphics, x-y coordinate system and how it is used in connection with screens), Informatics (programming, algorithms).

Learning outcomes: Student gets an overview of visual and auditory feedback devices. Main focus is on visual feedback and after completing this chapter, student will be able to choose a suitable type of visual output device for their robot.
Real life: We suggest explaining to students what kind of output devices their mobile phone (as an example of a robot) has. What kind of feedback does it give and how do we get it? What kind of a display does it have? How many pixels does it have? Can they see a picture taken with their phone camera on the screen without scaling? (In most cases, it is not possible as the camera makes more pixels than their screen allows to show). Debugging.

Sensors (6 lessons)

Lessons 9-14

Analog sensors / introduction.
Topics: We learn about analog sensors and have a look at examples. A/D converter.
Integration: Physics (light1 reflecting from various surfaces, how much black and white surfaces reflect, according to which principle the light sensor works, touch sensor as an electric switch, analog sensors' output, the analogue signal i.e. electrical voltage continuously variable in time); Informatics (programming, conditional sentences, if, switch, cycle)
Learning outcomes: After the completion this chapter, student can describe the operation of the analog sensors and A/D converter.
Real life: Which analog sensors can be found in homes? (a doorbell, the washing machine temperature sensor, analog microwave clock, etc.) Do newer phones have any analog sensors? (Usually not)
Digital sensors / lecture - practical work
Topics: We learn about digital sensors and have a look at examples.
Integration: Physics (you can talk about sound waves, their reflection, as this is how the sonar works), Mathematics (discrete functions can be pointed out as their input does not create a continuous output signal), Informatics (programming, conditional sentences, if, switch, cycle).
Learning outcomes: Student will be able to name digital sensors, describe their operation, and the digital signal. After completing this chapter, they will be able to select suitable sensors for their robot.
Real life: Students can name digital sensors found in their homes. (Unlike analog sensors, there are already many digital sensors inside the home appliances, for example, touch panels, computer mouses, etc.)

Developing STEM competence with robotics (2 lessons)

Lessons 15-16

Algorithmic thinking and teamwork skills / lecture - practical work
Topics: We learn to use algorithmic thinking and teamwork skills through several practical exercises.
Integration: Math, physics, programming. Algorithmic thinking is necessary whenever creating software of robotics, hardware systems. It is very connected to math and logic. Teamwork is horizontal principle included in most curriculums in schools.
Learning outcomes: Student describes 21st century skills (esp. communication, collaboration and creativity.) and knowledge to the term algorithm and algorithmic thinking.
Real life: Students can name places and situations where they have used algorithmic thinking or teamwork. Where do they think these skills are most needed in the future?

Driving base (4 lessons)

Lessons 17-20

Driving base and positioning / lecture - practical work

Topics: We learn various robotic motion driving mechanisms: differential-, omni wheel-, car-type robots.

Integration: Mathematics (equations, trigonometry), Physics (electric motors, generators, transmission, friction, inertia, acceleration, wheel and track, whether the tracks provide better friction, finding friction of the track and wheel), Informatics (programming, algorithms).

Learning outcomes: Student describes different movement mechanisms and their characteristics. After completing this chapter, they will be able to select the driving mechanism for their robot depending on the terrain.

Real life: How do self-driving cars move? What kind of positioning methods are these machines using? Which examples of motion mechanisms in everyday life can students give? Which driving mechanisms are cars using? (With wheels, differential)

Critical thinking on the robot field – choosing missions based on time and points (2 lessons)

Lessons 21-22

Critical thinking / lecture - practical work

Topics: 21st century skills and problem solving algorithms

Integration: 21st century skills are included in most curriculums not as a separate subject, but horizontal learning method. This lesson can be connected with most of the lessons where time and teamwork skills are criteria for success.

Learning outcomes: Students will learn how to think critically and how to create algorithms that solves certain problems.

Real life: 80 % of the jobs in the future require in addition to specific skillset also these skills what students are practicing in these lessons.

Data communication (4 lessons)

Lessons 23-26

Data communication / lecture - practical work

Topics: We will learn the most common basic data communication methods: bluetooth, data cable (daisy chain).

Integration: Physics (radio waves and their propagation under different conditions, such as terrain and urban environments, radio, telecommunications, measurements, data transmission using wires).

Learning outcomes: Student is able to describe digital communication, its principles and characteristics. They will be able to draw diagrams of the principle of data communication. After completing this chapter, student will be able to select the appropriate data communication solution for their robotics system.

Real life: What kind of communication modes are used in phones (phones communicate with each other by means of bluetooth) and TV with a remote control (wireless, using IR light)?

Data logging and processing (2 lessons)

Lessons 27-28

Data logging / lecture - practical work
Topics: We will learn the most common basic data logging methods.
Integration: Mathematics (analytics), physics (measuring physic values)
Learning outcomes: Student is able to understand basic principles about logging and collecting data, understand graphs, analyse these and make conclusions.
Real life: How is weather data collected, where else do we collect data in life? What do we do with it and use where?

Innovation project and presenting skills (4 lessons)

Lessons 29-32

Creating innovation projects, creating pitches and presentations / lecture - practical work
Topics: We will learn how to create innovative solutions and how to make presentations about it.
Integration: Presentation skills are needed in most of the subjects.
Learning outcomes: Student is able to understand basic principles about creating solutions for problems (research, innovate, share). Students can create their presentation in teams make it fun and interesting for investors to see.
Real life: Selling your ideas is valuable skill whatever you are doing. Creating solutions based on research and innovation is a needed for almost everybody that is working in the technical field in the future.

Programming (4 lessons)

Lessons 33-36

More advanced programming structures / lecture - practical work
Topics: Learning how to use constants, variables, logic, math and comparison in programming languages. Parallel and serial programming, interrupt.
Integration: Math (logic and comparison), informatics (variables, programming levels)
Learning outcomes: Student is able to understand programming concepts such as constant, variable, logical operations, comparison and use them in algorithms. Student knows what is the difference between serial and parallel programs and understands when to use one or another.
Real life: Do you recognize where these concepts are used around you? Can you point and name machines/robots next to you where you see these programming concepts used in the behavior? Like how the logic of the elevator is built?

Sumo challenge (4 lessons)

Lessons 37-40

Building and programming sumo robots / lecture - practical work

Topics: Learning how to build a sumo robot, factors to take into account. How to program robot to use different strategies?

Integration: Math (algorithms), physics (friction, center of mass, light conditions), mechanics

Learning outcomes: Students knows sumo principles and origin. Students know what are the important factors for building and programming a sumo robot.

Real life: In life we need critical thinking and this exercise will help to implement it on a small sumo robot that has size and weight limit. Good warriors have several strategies that they can choose from in the battle.