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CL-BVET: Education and Training for Collaborative Learning in Blended Learning Environments

Work Package 2: Competences and educational programs for cooperative learning

Report on Deliverable D8 (D2.5)

Developing collaborative learning programs with Open Badge in blended learning environments.

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Content

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INTRODUCTION

Developing collaborative learning programs with Open Badge in blended learning environments - 6 learning programs Croatian, Slovenian, Bosnian, Montenegrin, in English, paper and e-version

In the work plan, we had a defined work task:

T2.7 Developing training programmes for the acquisition of competences for collaborative learning

At the meeting of the partners, we agreed on the most necessary competences for collaborative learning that will be prepared by the educational programmes. Each partner has prepared at least one educational program. When preparing the programs, we took into account the common curriculum, the acquisition of the Open Badge and the possibility of implementing the program in blended learning environments.

We managed to prepare 7 very good education programs from 1 ECTS to 4 ECTS. All programmes are made on a common basis – the CL-BVET project's uniform curriculum, all have clearly defined competences and learning objectives, have an Open Badge and can be implemented in blended learning environments. The partners have prepared programs in cooperation with the environment, schools and companies – they have created the programs they need, can implement them and will also pilot them in the next phase of the project.

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Implementation of activities

Each partner chose and prepared the Open Badge training program on their own. The basic idea of the program, competencies, learning goals, and method of implementation was presented by each partner at the project working meeting in Gradiška (BiH). With their working group, they then designed a program based on the common curriculum. In the project, we planned to prepare 6 educational programs – and we successfully completed 7 of them. With that, we have exceeded the indicator.

The programs that have been created are very important for the environment of the partners. The programs they need to raise the capacity of vocational education have been developed. They are made in a self-made way – with knowledge tests, proof of knowledge and skills, digital certificates – Open Badge.

Nastali programi:

Z.št.	**Partner**	**Program (Open Badge)** **English name**	**Program (Open Badge)** **Name in the national language**
1.	JU Tehnička škola Gradiška	Implementation of PLC in automatic control in industry	Implementacija PLC-ova u automatskom upravljanju u industriji
2.	Inovaciono-preduzetnički centar Tehnopolis	CNC technologies in educational process	CNC tehnologije u nastavi
3.	Šolski center Novo mesto	Digital tools for effective project management	Digitalna orodja za učinkovito vodenje projektov
4.	Šolski center Novo mesto	PLC Fundamentals for Smart Manufacturing	Osnove digitalne industrijske avtomatizacije s PLK
5.	JU Srednja stručna škola Pljevlja	Creating simple automated systems using Arduino microcontrollers	Izrada jednostavnih automatizovanih sistema, upotrebom mikrokontrolera Arduino
6.	Srednja strukovna škola Velika Gorica	Realization of projects in 3D technologies	Realizacija projekata u 3D tehnologijama
7.	JU Centar za obrazovanje odraslih Banja Luka	Associate in the preparation and implementation of eu projects	Saradnik u pripremi i sprovođenju EU projekata

All programs are attached to the report in pdf format.

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Short training program Microcredentials (Open Badge)

CNC technologies in educational process

The training program was prepared by

Innovation and entrepreneurship center Tehnopolis

Experts:

Tihomir Ćuzović, Anđela Nikčević

Providers of the educational program

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Project partners: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna skola Velika Gorica (Croatia), Tehnicka skola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja strucna skola Pljevlja, Inovaciono-preduzetnički centar Tehnopolis (Montenegro)

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Basic information about the training program

Title of the training programme:

CNC technologies in educational process

Duration of the training program:

100 hours

Credits:

4 credit point ECTS

Educational areas:

Mechanical engineering and manufacturing technologies, CNC technologies and computer-controlled production, CAD/CAM systems and digital modeling, industrial automation and production processes, technical drawing and engineering graphics, mechatronics and modern manufacturing systems, educational technologies and vocational teaching didactics, blended learning and digital pedagogy.

Certificates and badges obtained:

Upon successful completion of the "CNC Technologies in educational process" program, participants receive a certificate of training, which confirms the acquisition of knowledge and skills in the fields of CAD modeling, CAM programming, CNC technologies, and their application in the teaching process. In addition to the certificate, participants are awarded Open Badges for individual program modules, digitally validating competencies in the following areas: -CAD modeling -CAM programming and simulation -Basics of CNC technologies and milling processes -Practical work on CNC routers and blended learning The Open Badge enables verification of specific knowledge and skills and their presentation on professional platforms and learning management systems.

1. Description and target group of the training programme:

Program Description

The goal of the "CNC Technologies in educational process" program is to train teachers of technical and vocational subjects in the application of CAD and CAM technologies, understanding CNC processes, and confident and efficient operation of CNC routers, while developing competencies for planning and delivering modern (blended) teaching.

The program enables participants to acquire knowledge and skills through four interconnected modules for:

-Creating technically accurate 3D CAD models

-Using CAM software

-Understanding CNC technologies and milling processes

-Practical application of CNC routers in an educational environment

-Planning and implementing teaching activities based on CNC technologies

Special emphasis is placed on connecting digital modeling, manufacturing processes, and pedagogical application in teaching.

Target group

The target group of the program consists of teachers of technical subjects, including the fields of mechanical engineering, mechatronics, manufacturing technologies, and related technical disciplines, who wish to improve their competencies in CNC technologies and digital manufacturing.

The program is specifically designed for:

Teachers with little or no prior experience in CAD/CAM/CNC technologies

Teachers who want to introduce modern digital manufacturing technologies into their teaching

Teachers developing competencies for delivering practical and project-based (blended) learning

Teachers who aim to connect industrial CNC processes with the educational environment and transfer practical knowledge to students

2. Competence

Through the training, the participant (s) develops the following professional competences:

- Uses CAD software to create 3D models intended for CNC machining.
- Applies technical drawing and modeling rules in the creation of digital models and technical documentation.
- Uses CAM software to prepare CNC programs, including defining tools, workpieces, and machining operations.
- Simulates CNC machining processes and analyzes simulation results to optimize processes and correct errors.
- Understands the basic principles of CNC technology, milling processes, and safety procedures when working with CNC routers.
- Safely prepares and operates CNC routers in an educational environment to produce simple parts.
- Analyzes deviations and the quality of produced parts using basic measuring tools.
- Plans and implements teaching activities (bl learning) based on CAD/CAM/CNC processes and their application in teaching.

3. Learning objectives

Competence: Usage of CAD software to create technically accurate 3D models intended for CNC machining.

Participant(s)

- - Become familiar with the basic CAD environment and modeling tools
- - Create 2D sketches as a foundation for 3D models
- - Develop simple 3D models using basic CAD commands
- - Prepare the CAD model for further CAM processing

Competence: **Application of technical drawing and modeling rules in creating digital models and technical documentation.**

Participant(s)

- Applies technical drawing standards in a digital environment

- Creates technical drawings based on 3D models
- Correctly annotates and dimension the model
- Accurately dimensions the model
- Prepares complete and organized technical documentation

Competence: **Using CAM software to create CNC programs, including tool definition, workpiece setup, and machining operations.**

Participant(s)

- Import the CAD model into the CAM environment
- Define the workpiece, coordinate system, and tools
- Select appropriate machining operations (milling)
- Generate a basic CNC (NC) program

Competence: **Simulating CNC machining processes and analyzing simulation results for process optimization and error correction**

Participant(s)

- Runs the CAM process simulation
- Identifies errors in the toolpath
- Analyzes deviations and tolerances
- Performs program corrections based on the simulation

Competence: **Independence and responsibility in a virtual team**

Participant(s)

- Explains the importance of independent work and personal responsibility in a virtual team,
- Defines own tasks, deadlines, and responsibilities within the project process,
- Carries out assigned tasks in accordance with agreed rules and timelines,
- Adheres to principles of responsible conduct, reliability, and a collaborative culture.

Competence: **Understanding the basic principles of CNC technology, processes, and safety procedures when operating a CNC router.**

Participant(s)

- Explains basic concepts of CNC technology
- Describes the stages of the CNC milling process
- Identifies safety risks when working with CNC machines
- Applies basic safety rules during operation

Competence: **Independence and responsibility in a virtual team**

Participant(s)

- Explains the importance of independent work and personal responsibility in a virtual team,
- Defines own tasks, deadlines, and responsibilities within the project process,
- Carries out assigned tasks in accordance with agreed rules and timelines,
- Adheres to principles of responsible conduct, reliability, and a collaborative culture.

Competence: **Safe preparation and operation of CNC routers in an educational environment for producing simple parts.**

Participant(s)

- Prepares the CNC router for operation (material, tool, zero point)
- Starts the NC program and monitors the machining process
- Responds to basic issues during machine operation
- Performs simple machining tasks under safe conditions

Competence: **Analyzing deviations and quality of produced parts using basic measuring tools.**

Participant(s)

- Uses basic measuring tools (caliper, micrometer)
- Compares the manufactured part with the technical drawing
- Identifies deviations and machining errors
- Assesses the quality of the produced product

Competence: **Planning and implementation of teaching activities (blended learning) based on CAD/CAM/CNC processes and their application in teaching.**

Participant(s)

- Designs a teaching unit based on CNC technology
- Plans student activities within the CAD/CAM/CNC process
- Integrates online and practical parts of teaching (blended model)
- Prepares teaching materials and activity implementation plans

4. Structure of the training programme

No.	MODULE NAME	NUMBER OF POINTS KT (ECTS)	Number of hours (h)		
			T	PW	TOTAL
1.	CAD modeling	1	10	15	25
2.	CAM programming and simulation	1	10	15	25
3.	Basics of CNC technologies and milling process	1	10	15	25
4.	Practical work on CNC router and blended learning	1	10	15	25
		TOTAL	**40**	**60**	**100**

Module 1: CAD modeling

Objectives:
Enabling participants to create technically accurate 3D CAD models of simple parts that can be used in CNC manufacturing and technical subject teaching.

Content:

- Introduction to CAD software (e.g., Solid Edge or similar industry standard)
- Basic commands for 2D sketching and 3D modeling (Extrude, Revolve, Cut)
- Technical drawing rules and proper sketch definition
- Creating simple 3D models of various geometries
- Exporting models to CAM software
- Preparing basic technical documentation (drawings, dimensioning, views)

- Exporting CAD models in appropriate formats

Methods: interactive lectures, demonstrations of CAD software usage, guided practical exercises, independent work by participants, and consultations. Special emphasis is placed on learning through hands-on tasks where participants create their own 3D models with mentor support.

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Module 2: CAM programming and simulation

Objectives:
Enabling participants to use CAM software for CNC machining preparation, including tool definition, milling operations, process simulation, and NC code generation.

Content:

- Introduction to the CAM environment and importing CAD models
- Defining the workpiece, coordinate system, and zero point
- Selecting tools and basic milling operations
- Creating toolpaths
- Simulating the machining process
- Analyzing deviations and correcting errors
- Generating NC code and basics of post-processing
- Basic interpretation of NC code

Methods: interactive lectures, demonstrations of CAM software operation, practical exercises on assigned models, machining process simulations, analysis of real-world case studies, and independent participant work with mentor support and consultations.

Module 3: Basics of CNC technologies and milling process

Objectives:
Enable participants to understand the basic principles of CNC technology, the structure of CNC systems, milling processes, and safety rules for working in a CNC environment, providing a foundation for practical application in teaching and manufacturing.

Content:

- Basic concepts of CNC technology (Computer Numerical Control)
- Types of CNC machines and their main characteristics
- Operation principles of CNC systems and control units
- Stages of the CNC milling process (preparation, programming, machining, inspection)
- Basic tools and materials used in CNC milling
- Safety rules and work organization in the CNC environment
- Application of CNC technology in industry and education

Methods: interactive lectures, multimedia presentations, analysis of real industrial examples (case studies), guided discussions, demonstrations of CNC system operation (video and live where possible), as well as independent participant work with consultations and mentor support.

Module 4: Practical work on CNC router and blended learning

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Objectives:
Enable participants to safely prepare and operate CNC routers, produce simple CNC products, conduct quality control of manufactured parts, and plan and implement blended learning in the educational process.

Content:

- Preparing the CNC router for operation (cleaning, lubrication, system checks)
- Setting up and securing the material (workpiece)
- Selecting and mounting tools
- Finding the work zero point and starting the NC program
- Monitoring the machining process and responding to errors
- Quality control of the produced part (measuring tools and deviation analysis)
- Planning a blended teaching model (online + practical lessons)
- Documenting the teaching process and outcomes

Methods: practical work on the CNC router, instructor demonstrations, mentored workshops, process simulations, individual and team work, analysis of real production scenarios, and development of teaching scenarios within a blended learning approach.

5. Method of execution

Training/teaching is conducted both in the classroom/workshop on the CNC router and online:

The program is delivered through a blended learning approach with a total duration of 100 hours, divided into 4 modules of 25 hours each.

Each module includes a combination of:

- Live teaching in the classroom and/or workshop (theoretical and demonstration parts)
- Practical work on the computer (CAD/CAM software)
- Online learning and independent study
- Consultations and mentor-guided activities

Module structure:
- Module 1 – CAD modeling (25 hours)
- Module 2 – CAM programming and simulation (25 hours)
- Module 3 – Basics of CNC technologies and milling process (25 hours)
- Module 4 – Practical work on CNC router and blended learning (25 hours)

Teaching methods: interactive lectures with multimedia presentations, demonstrations of CAD and CAM software, guided practical exercises on computers and CNC simulations, hands-on work in CAD/CAM environments on real tasks, practical work on CNC routers (within the final module), project-based learning (creating CAD/CAM/CNC projects), analysis of industrial case studies, solving problem-based tasks from real production situations, individual and team work, mentoring and consultations, online learning via an e-platform (video lessons, assignments, forum discussions), and presentation and defense of completed solutions.

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6. Assessment of knowledge

The assessment of knowledge and skills is conducted through a combination of theoretical tests, practical tasks and evaluation of project work. The assessment includes:

- Testing theoretical knowledge of CAD, CAM, and CNC technologies
- Practical tasks in creating 3D CAD models
- Development of a CAM project with defined operations and machining simulation
- Creation and analysis of NC code
- Practical work on the CNC router (preparation, machining, and quality control)
- Preparation of a teaching scenario (blended learning)
- Defense and presentation of the completed project solution

The final grade is based on overall performance in the theoretical part, practical work, and the quality of the project solution.

The practical exam is conducted in three parts:

1. Completion of the project task (CAD/CAM/CNC solution), including:

- Creating a 3D CAD model of the assigned or chosen part
- Preparing the CAM process (defining tools, operations, and machining parameters)
- Simulating machining and correcting errors
- Generating NC code
- Preparing technical documentation for the solution

2. Presentation of the project development process and results, including explanations of:

- The CAD model and technical solution
- CAM preparation and simulation
- CNC machining process and expected outcomes
- Application of the solution in teaching or production environments

3. Answering questions from the Committee to verify understanding of:

- CAD and CAM processes and their interrelation
- Basic CNC principles and safety rules
- Interpretation of NC code
- Application of CNC technology in education and industry

Evaluation criteria:

The assessment of participants' knowledge and skills is based on the following criteria. Each criterion is scored from 0 to 2 points, with a maximum total score of 14 points.

1. Quality and accuracy of the 3D CAD model

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2. Application of technical drawing rules and neatness of technical documentation 3. Quality of CAM preparation (tools, operations, machining parameters) 4. Accuracy and functionality of CNC machining simulation 5. Understanding and interpretation of NC code 6. Successful execution of CNC machining process and quality control of the produced part 7. Quality of presentation, professional communication, and answers to Committee questions

Rating formatting:

- 0 – Criterion not met
- 1 – Criterion partially met
- 2 – Criterion fully met

Participants successfully complete the program if they score at least 8 out of 14 points on the practical exam.

Based on the total points earned, the success levels are determined as follows:

- 0–7 points – did not pass
- 8–11 points – passed
- 12–14 points – passed with high distinction

Upon completion of the program, participants receive a certificate of competence for applying CNC technologies in teaching, including CAD modeling, CAM programming, CNC machining, and the development of teaching activities based on digital manufacturing.

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Open Badge

Innovation and entrepreneurship center Tehnopolis, Radoja Dakića bb, 81400 Nikšić

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Link via website: https://www.cl-bvet.eu/education-and-training/

To earn the Open Badge, a participant must successfully complete the training program and meet the following conditions:

- Successful attendance and completion of the entire training program
- Creation of a functional CAD/CAM/CNC project task
- Preparation and submission of complete technical documentation (CAD drawings, CAM project, NC code, and solution description)
- Successful simulation and/or execution of CNC machining
- Preparation and delivery of a short presentation (7–10 slides) of the completed solution
- Positive evaluation of the project task, documentation, and presentation by the Committee

Task selection:

1. The participant chooses or is assigned a project task in the field of CAD/CAM/CNC technologies, which includes the creation of a functional technical solution.
2. The task involves creating a 3D CAD model, CAM preparation, machining simulation, and (if possible) execution on a CNC router.
3. Use of existing or previously created solutions is not allowed.
4. The project must be independently created, tested, and documented.
5. The completed project task and technical documentation must be submitted via the link provided below.

Presentation:

1. Prepare a short presentation (7–10 slides) that showcases the problem, CAD model, CAM process, CNC machining, and the results.
2. The presentation should include visual representations of the work (images, simulations, or video recordings of the process).
3. The presentation must be submitted via the link provided below.

Submission date:

1. **All digital files (CAD file, CAM project, NC code, technical documentation, and presentation) must be submitted no later than _____**

Submission and registration link:
https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

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7. Quality assurance method

Quality assurance is carried out in accordance with the Rules on the Quality Assurance System for Short Programmes with Micro-Evidence …….

Kratki program obuke Microcredentials (Open Badge)

CNC tehnologije u nastavi

Program treninga pripremili su:

Inovaciono-preduzetnički centar Tehnopolis

Stručni tim:

Tihomir Ćuzović, menadžer TechLaba, Anđela Nikčević, menadžerka za upravljanje projektima

Inicijatori obrazovnog programa

Projekat: ***CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments***

Partneri na projektu: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna skola Velika Gorica (Croatia), Tehnicka skola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja strucna skola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro)

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Osnovne informacije o programu

Naziv programa:

CNC tehnologije u nastavi

Trajanje programa:

100 sati

Vrednovanje:

4 KT (ECTS)

Obrazovna područja:

Program „CNC tehnologije u nastavi“ pripada sljedećim obrazovnim područjima:

- Mašinstvo i proizvodne tehnologije
- CNC tehnologije i računalno upravljana proizvodnja
- CAD/CAM sistemi i digitalno modelovanje
- Industrijska automatizacija i proizvodni procesi
- Tehničko crtanje i inženjerska grafika
- Mehatronika i savremeni proizvodni sistemi
- Obrazovne tehnologije i didaktika stručne nastave
- Blended learning i digitalna pedagogija

Dobijeni sertifikati i bedževi:

Po uspješnom završetku programa „CNC tehnologije u nastavi“ polaznici dobijaju sertifikat o završenoj obuci, kojim se potvrđuje sticanje znanja i vještina iz oblasti CAD modelovanja, CAM programiranja, CNC tehnologija i primjene u nastavnom procesu.

Pored sertifikata, polaznicima se dodjeljuju Open Badge (otvoreni bedževi) za pojedinačne module programa, koji digitalno potvrđuju stečene kompetencije u sljedećim oblastima:

- CAD modelovanje
- CAM programiranje i simulacija
- Osnove CNC tehnologija i procesa glodanja
- Praktični rad na CNC ruteru i blended nastava

Open Badge omogućava verifikaciju specifičnih znanja i vještina te njihovo predstavljanje na profesionalnim platformama i u sistemima za upravljanje učenjem.

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Sertifikat i Open Badge zajedno potvrđuju osposobljenost polaznika za primjenu CNC tehnologija u obrazovnom procesu i realizaciju savremene tehničke nastave zasnovane na digitalnim proizvodnim tehnologijama.

Opis i ciljna grupa programa sposobljavanja:

Opis programa

Cilj programa „CNC tehnologije u nastavi“ je osposobiti nastavnike tehničkih i stručnih predmeta za primjenu CAD i CAM tehnologija, razumijevanje CNC procesa te siguran i efikasan rad na CNC ruteru, uz razvoj kompetencija za planiranje i izvođenje savremene (blended) nastave.

Program omogućava polaznicima da kroz četiri međusobno povezana modula steknu znanja i vještine za:

- izradu tehnički ispravnih 3D CAD modela,
- pripremu i simulaciju CAM procesa obrade,
- razumijevanje CNC tehnologija i procesa glodanja,
- praktičnu primjenu CNC rutera u obrazovnom okruženju,
- planiranje i realizaciju nastavnih aktivnosti zasnovanih na CNC tehnologijama.

Poseban naglasak stavlja se na povezivanje digitalnog modelovanja, proizvodnih procesa i pedagoške primjene u nastavi.

Ciljna grupa

Ciljna grupa programa su nastavnici tehničke grupe predmeta, uključujući oblasti mašinstva, mehatronike, proizvodnih tehnologija i srodnih tehničkih disciplina, koji žele unaprijediti svoje kompetencije u oblasti CNC tehnologija i digitalne proizvodnje.

Program je posebno namijenjen:

- nastavnicima bez prethodnog ili sa ograničenim iskustvom u CAD/CAM/CNC tehnologijama,
- nastavnicima koji žele uvesti savremene digitalne proizvodne tehnologije u nastavu,
- nastavnicima koji razvijaju kompetencije za izvođenje praktične i projektne (blended) nastave,
- polaznicima koji žele povezati industrijske CNC procese sa obrazovnim okruženjem i učenicima prenijeti praktična znanja.

Vještine (kompetencije)

Po završetku programa „CNC tehnologije u nastavi“ polaznik će biti osposobljen da:

- **Koristi CAD softver za izradu tehnički ispravnih 2D i 3D modela namijenjenih CNC obradi.**
- **Primjenjuje pravila tehničkog crtanja i modelovanja u izradi digitalnih modela i tehničke dokumentacije.**
- **Koristi CAM softver za pripremu CNC programa, uključujući definisanje alata, pripremka i operacija obrade.**
- **Simulira CNC procese obrade i analizira rezultate simulacije radi optimizacije procesa i korekcije grešaka.**
- **Razumije osnovne principe CNC tehnologije, procesa glodanja i sigurnosnih procedura u radu sa CNC ruterom.**
- **Sigurno priprema i koristi CNC ruter u obrazovnom okruženju za izradu jednostavnih dijelova.**
- **Analizira odstupanja i kvalitet izrađenih dijelova korištenjem osnovnih mjernih alata.**
- **Planira i realizuje nastavne aktivnosti (blended learning) zasnovane na CAD/CAM/CNC procesima i primjeni u nastavi.**

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Ciljevi učenja

Kompetencija 1:

Koristi CAD softver za izradu tehnički ispravnih 2D i 3D modela namijenjenih CNC obradi.

Ciljevi učenja:

- Upoznati osnovno CAD okruženje i alate za modelovanje
- Kreirati 2D skice kao osnovu za 3D model
- Izraditi jednostavne 3D modele primjenom osnovnih CAD komandi
- Pripremiti CAD model za dalju CAM obradu

Kompetencija 2:

Primjenjuje pravila tehničkog crtanja i modelovanja u izradi digitalnih modela i tehničke dokumentacije.

Ciljevi učenja:

- Primijeniti standarde tehničkog crtanja u digitalnom okruženju
- Izraditi tehnički crtež na osnovu 3D modela
- Obezbijediti pravilnu kotaciju i dimenzionisanje modela
- Pripremiti urednu tehničku dokumentaciju

Kompetencija 3:

Koristi CAM softver za pripremu CNC programa, uključujući definisanje alata, pripremka i operacija obrade.

Ciljevi učenja:

- Importovati CAD model u CAM okruženje
- Definisati pripremak, koordinatni sistem i alate
- Izabrati odgovarajuće operacije obrade (glodanje)
- Generisati osnovni CNC (NC) program

Kompetencija 4:

Simulira CNC procese obrade i analizira rezultate simulacije radi optimizacije procesa i korekcije grešaka.

Ciljevi učenja:

- Pokrenuti simulaciju CAM procesa

- Prepoznati greške u putanji alata
- Analizirati odstupanja i tolerancije
- Izvršiti korekcije programa na osnovu simulacije

Kompetencija 5:

Razumije osnovne principe CNC tehnologije, procesa glodanja i sigurnosnih procedura u radu sa CNC ruterom.

Ciljevi učenja:

- Objasniti osnovne pojmove CNC tehnologije
- Opisati faze procesa CNC glodanja
- Prepoznati sigurnosne rizike u radu na CNC mašini
- Primijeniti osnovna sigurnosna pravila u radu

Kompetencija 6:

Sigurno priprema i koristi CNC ruter u obrazovnom okruženju za izradu jednostavnih dijelova.

Ciljevi učenja:

- Pripremiti CNC ruter za rad (materijal, alat, nulta tačka)
- Pokrenuti i nadzirati CNC proces obrade
- Reagovati na osnovne probleme tokom rada mašine
- Izvesti jednostavnu CNC obradu u sigurnim uslovima

Kompetencija 7:

Analizira odstupanja i kvalitet izrađenih dijelova korištenjem osnovnih mjernih alata.

Ciljevi učenja:

- Koristiti osnovne mjerne alate (šubler, mikrometar)
- Uporediti izrađeni dio sa tehničkim crtežom
- Identifikovati odstupanja i greške u obradi
- Procijeniti kvalitet izrađenog proizvoda

Kompetencija 8:

Planira i realizuje nastavne aktivnosti (blended learning) zasnovane na CAD/CAM/CNC procesima i primjeni u nastavi.

Ciljevi učenja:

- Osmisliti nastavnu jedinicu zasnovanu na CNC tehnologiji

- Planirati aktivnosti učenika u CAD/CAM/CNC procesu
- Integrisati online i praktični dio nastave (blended model)
- Izraditi nastavne materijale i plan izvođenja aktivnosti

Struktura programa osposobljavanja

Z. št.	NAZIV MODULA	Broj bodova (*ECTS*)	Sati (h)		
			T	P	UKUPNO
1.	CAD MODELOVANJE	1	10	15	25
2.	CAM PROGRAMIRANJE I SIMULACIJA	1	10	15	25
3.	OSNOVE CNC TEHNOLOGIJA I PROCES GLODANJA	1	10	15	25
4.	PRAKTIČNI RAD NA CNC RUTERU I BLENDED NASTAVA	1	10	15	25
	UKUPNO		**40**	**60**	**100**

MODUL 1: CAD MODELOVANJE

Cilj:

Osposobiti polaznike za izradu tehnički ispravnih 2D i 3D CAD modela jednostavnih dijelova, koji se mogu koristiti u CNC proizvodnji i nastavi tehničkih predmeta.

Sadržaj:

- Uvod u CAD softver (npr. Solid Edge ili sličan industrijski standard)
- Osnovne komande za 2D skiciranje i 3D modelovanje (Extrude, Revolve, Cut)
- Pravila tehničkog crtanja i pravilna izrada skica
- Izrada jednostavnih 3D modela različitih geometrija
- Priprema modela za CAM obradu
- Izrada osnovne tehničke dokumentacije (crtež, kotiranje, prikazi)
- Čuvanje i izvoz CAD modela u odgovarajućim formatima

Ishodi učenja:

Po završetku modula polaznik će biti u stanju da:

- Objasni osnovne funkcije i radno okruženje CAD softvera
- Koristi osnovne CAD alate za izradu 2D skica i 3D modela
- Primijeni pravila tehničkog crtanja u digitalnom modelovanju
- Izradi tehnički ispravan 3D model jednostavnog dijela
- Izradi osnovnu tehničku dokumentaciju (tehnički crtež sa kotiranjem i prikazima)

- Pripremi CAD model za dalju CAM obradu i CNC proizvodnju
- Sačuva i izveze modele u odgovarajućim formatima za dalju upotrebu

Metode:

Nastava se realizuje kroz interaktivna predavanja, demonstracije rada u CAD softveru, vođene praktične vježbe, samostalni rad polaznika i konsultacije. Poseban naglasak stavlja se na učenje kroz praktične zadatke gdje polaznici izrađuju vlastite 2D i 3D modele uz mentorsku podršku.

MODUL 2: CAM PROGRAMIRANJE I SIMULACIJA

Cilj:

Osposobiti polaznike za korištenje CAM softvera za pripremu CNC obrade, uključujući definisanje alata, operacija glodanja, simulaciju procesa i generisanje NC koda.

Sadržaj:

- Uvod u CAM okruženje i uvoz CAD modela
- Definisanje pripremka, koordinatnog sistema i nulte tačke
- Odabir alata i osnovnih operacija glodanja
- Kreiranje putanje alata (toolpath)
- Simulacija procesa obrade
- Analiza odstupanja i korekcija grešaka
- Generisanje NC koda i osnove postprocesiranja
- Osnovno tumačenje NC koda

Ishodi učenja:

Po završetku modula polaznik će biti u stanju da:

- Importuje CAD model u CAM okruženje
- Definiše pripremak, alate i radne koordinate
- Kreira osnovne operacije glodanja i putanju alata
- Izvede simulaciju obrade i analizira rezultate
- Prepozna greške i izvrši korekcije u CAM programu
- Generiše NC kod za CNC obradu
- Objasni osnovnu strukturu i funkciju NC koda

Metode:

Nastava se realizuje kroz interaktivna predavanja, demonstracije rada u CAM softveru, praktične vježbe na zadanim modelima, simulacije procesa obrade, analizu slučajeva iz prakse i samostalan rad polaznika uz mentorsku podršku i konsultacije.

MODUL 3: OSNOVE CNC TEHNOLOGIJA I PROCES GLODANJA

Cilj:

Osposobiti polaznike za razumijevanje osnovnih principa CNC tehnologije, strukture CNC sistema, procesa glodanja i sigurnosnih pravila rada u CNC okruženju, kao osnove za praktičnu primjenu u nastavi i proizvodnji.

Sadržaj:

- Osnovni pojmovi CNC tehnologije (Computer Numerical Control)
- Vrste CNC mašina i osnovne karakteristike
- Princip rada CNC sistema i upravljačkih jedinica
- Faze procesa CNC glodanja (priprema, programiranje, obrada, kontrola)
- Osnovni alati i materijali u CNC glodanju
- Sigurnosna pravila i organizacija rada u CNC okruženju
- Primjena CNC tehnologije u industriji i obrazovanju

Ishodi učenja:

Po završetku modula polaznik će biti u stanju da:

- Objasni osnovni pojam i principe CNC tehnologije
- Razlikuje vrste CNC mašina i njihove osnovne primjene
- Opisuje faze procesa CNC glodanja
- Prepozna osnovne alate i materijale u CNC obradi
- Primjenjuje osnovna sigurnosna pravila pri radu na CNC sistemima
- Poveže teorijska znanja sa praktičnom primjenom CNC tehnologije

Metode:

Nastava se realizuje kroz interaktivna predavanja, multimedijalne prezentacije, analizu stvarnih industrijskih primjera (case study), vođene diskusije, demonstracije rada CNC sistema (video i uživo gdje je moguće) te samostalan rad polaznika uz konsultacije i mentorsku podršku.

MODUL 4: PRAKTIČNI RAD NA CNC RUTERU I BLENDED NASTAVA

Cilj:

Osposobiti polaznike za sigurnu pripremu i upotrebu CNC rutera, izradu jednostavnih CNC proizvoda, kontrolu kvaliteta izrađenih dijelova te planiranje i realizaciju blended nastave u obrazovnom procesu.

Sadržaj:

- Priprema CNC rutera za rad (čišćenje, podmazivanje, provjera sistema)

- Postavljanje i stezanje materijala (pripremka)
- Odabir i montaža alata
- Podešavanje radne nule i pokretanje NC programa
- Praćenje procesa obrade i reagovanje na greške
- Kontrola kvaliteta izrađenog dijela (mjerni alati i analiza odstupanja)
- Planiranje blended nastavnog modela (online + praktična nastava)
- Dokumentovanje nastavnog procesa i rezultata

Ishodi učenja:

Po završetku modula polaznik će biti u stanju da:

- Pripremi CNC ruter za siguran rad
- Postavi i učvrsti materijal i alat u skladu sa zadatkom
- Pokrene i nadzire CNC obradu prema NC programu
- Identifikuje i reaguje na osnovne probleme tokom obrade
- Izvrši mjerenje i kontrolu kvaliteta izrađenog dijela
- Analizira odstupanja u odnosu na tehnički crtež i simulaciju
- Izradi plan blended nastavne aktivnosti za učenike

Metode:

Nastava se realizuje kroz praktičan rad na CNC ruteru, demonstracije instruktora, mentorisane radionice, simulacije procesa, individualni i timski rad, analizu stvarnih proizvodnih situacija te izradu nastavnih scenarija u okviru blended learning pristupa.

Način realziacije (sprovođenja)

Obuka/nastava se realzuje u učionici, u laboratoriji na opremi i online:

Program se realizuje kombinovanim načinom učenja (blended learning) u ukupnom trajanju od 100 časova, raspoređenih kroz 4 modula po 25 časova.

Svaki modul uključuje kombinaciju:

- nastave uživo u učionici i/ili radionici (teorijski i demonstracioni dio),
- praktičnog rada na računaru (CAD/CAM softver),
- online učenja i samostalnog rada,
- konsultacija i mentorski vođenih aktivnosti.

Struktura realizacije po modulima:

- Modul 1 – CAD modelovanje (25 časova)
- Modul 2 – CAM programiranje i simulacija (25 časova)

- Modul 3 – Osnove CNC tehnologija i proces glodanja (25 časova)
- Modul 4 – Praktični rad na CNC ruteru i blended nastava (25 časova)

Ukupno: 100 časova

Metode realizacije uključuju kombinaciju interaktivne nastave, demonstracija, praktičnih vježbi, simulacija, projektnog rada, analize slučajeva iz prakse, individualnog i timskog rada te online učenja putem e-platforme.

Poseban naglasak stavlja se na praktičnu primjenu znanja kroz CAD/CAM/CNC projekte i razvoj nastavnih scenarija u okviru blended learning modela.

Metode obuke:

U realizaciji programa primjenjuju se savremene nastavne metode koje omogućavaju povezivanje teorijskih znanja sa praktičnom primjenom u CAD/CAM/CNC okruženju i obrazovnoj praksi.

Metode obuke uključuju:

- interaktivna predavanja uz multimedijalne prezentacije
- demonstracije rada u CAD i CAM softveru
- vođene praktične vježbe na računaru i CNC simulacijama
- praktičan rad u CAD/CAM okruženju na konkretnim zadacima
- praktičan rad na CNC ruteru (u okviru završnog modula)
- projektni pristup učenju (izrada CAD/CAM/CNC projekta)
- analiza slučajeva iz industrijske prakse (case study)
- rješavanje problemskih zadataka iz realnih proizvodnih situacija
- individualni i timski rad polaznika
- mentorsko vođenje i konsultacije
- online učenje putem e-platforme (video lekcije, zadaci, forum diskusija)
- prezentacija i odbrana izrađenih rješenja

Procjena znanja i vještina

Procjena znanja i vještina realizuje se kroz kombinaciju teorijske provjere, praktičnih zadataka i evaluacije projektnog rada.

Procjena obuhvata:

- provjeru teorijskog znanja iz CAD, CAM i CNC tehnologija
- praktične zadatke iz izrade 2D i 3D CAD modela
- izradu CAM projekta sa definisanim operacijama i simulacijom obrade

- izradu i analizu NC koda
- praktični rad na CNC ruteru (priprema, obrada i kontrola kvaliteta)
- izradu nastavnog scenarija (blended learning)
- odbranu i prezentaciju izrađenog projektnog rješenja

Oblici procjene:

- elektronski test (teorijska znanja)
- praktični zadaci u CAD/CAM okruženju
- evaluacija rada na CNC ruteru
- ocjena projektnog zadatka i tehničke dokumentacije
- prezentacija i odbrana rješenja pred komisijom

Završna ocjena zasniva se na ukupnom uspjehu u teorijskom dijelu, praktičnom radu i kvaliteti projektnog rješenja.

Praktični ispit odvija se u tri dela:

1. **Izrada projektnog zadatka (CAD/CAM/CNC rješenje), koji obuhvata:**
   - izradu 3D CAD modela zadatog ili odabranog dijela;
   - pripremu CAM procesa (definisanje alata, operacija i parametara obrade);
   - simulaciju obrade i korekciju grešaka;
   - generisanje NC koda;
   - izradu tehničke dokumentacije rješenja.

2. **Prezentacija procesa izrade i rezultata projektnog zadatka, uz obrazloženje:**
   - CAD modela i tehničkog rješenja;
   - CAM pripreme i simulacije;
   - procesa CNC obrade i očekivanih rezultata;
   - primjene rješenja u nastavi ili proizvodnom okruženju.

3. **Odgovaranje na pitanja Komisije radi provjere razumijevanja:**
   - CAD i CAM procesa i njihove povezanosti;
   - osnovnih CNC principa i sigurnosnih pravila;
   - interpretacije NC koda;
   - primjene CNC tehnologije u obrazovanju i industriji.

Kriterijumi ocjenjivanja:

Procjena znanja i vještina polaznika vrši se po sljedećim kriterijumima. Svaki kriterijum se ocjenjuje u rasponu od 0 do 2 boda, pri čemu maksimalan broj bodova iznosi 14.

Kriterijumi ocjenjivanja:

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- Kvalitet i ispravnost 3D CAD modela
- Primjena pravila tehničkog crtanja i urednost tehničke dokumentacije
- Kvalitet CAM pripreme (alat, operacije, parametri obrade)
- Ispravnost i funkcionalnost simulacije CNC obrade
- Kvalitet generisanog NC koda i razumijevanje njegove strukture
- Uspješnost realizacije CNC procesa i kontrola kvaliteta izrađenog dijela
- Kvalitet prezentacije, stručna komunikacija i odgovori na pitanja Komisije

Skala ocjenjivanja:

0 – kriterijum nije ispunjen
1 – kriterijum je djelimično ispunjen
2 – kriterijum je u potpunosti ispunjen

USLOVI ZA ZAVRŠETAK PROGRAMA I USPEŠNOST

Polaznik uspješno završava program ukoliko na praktičnom ispitu ostvari najmanje 8 bodova od ukupno 14 mogućih bodova.

Na osnovu ukupnog broja ostvarenih bodova, uspjeh se utvrđuje na sljedeći način:

- 0–7 bodova – nije položio/la
- 8–11 bodova – položio/la
- 12–14 bodova – položio/la sa visokim uspjehom

Završetkom programa polaznik stiče potvrdu o osposobljenosti za primjenu CNC tehnologija u nastavi, uključujući CAD modelovanje, CAM programiranje, CNC obradu i izradu nastavnih aktivnosti zasnovanih na digitalnoj proizvodnji.

POSTUPAK ZA STICANJE OPEN BADGE (OTVORENOG BEDEŽA)

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Poveznica putem web stranice: https://www.cl-bvet.eu/education-and-training/

Za dobijanje Open Badge (Otvorenog bedža) potrebno je da polaznik uspješno završi program obuke i ispuni sljedeće uslove:

- uspješno pohađanje i završetak cjelokupnog programa obuke
- izrada funkcionalnog CAD/CAM/CNC projektnog zadatka
- izrada i predaja kompletne tehničke dokumentacije (CAD crteži, CAM projekat, NC kod i opis rješenja)
- uspješna simulacija i/ili realizacija CNC obrade
- priprema i izvođenje kratke prezentacije (7–10 slajdova) izrađenog rješenja
- pozitivna ocjena projektnog zadatka, dokumentacije i prezentacije od strane komisije

Open Badge se dodjeljuje polaznicima koji su dokazali stečene kompetencije u oblasti CAD modelovanja, CAM programiranja, CNC tehnologija i primjene u nastavi kroz praktičan projektni rad i evaluaciju.

Izbor zadatka:

1. Polaznik bira ili dobija zadati projektni zadatak iz oblasti CAD/CAM/CNC tehnologija koji uključuje izradu funkcionalnog tehničkog rješenja.
2. Zadatak obuhvata izradu 3D CAD modela, CAM pripremu, simulaciju obrade i (po mogućnosti) realizaciju na CNC ruteru.
3. Nije dopuštena upotreba već postojećih ili ranije izrađenih rješenja.
4. Projekat mora biti samostalno izrađen, testiran i dokumentovan.
5. Završeni projektni zadatak i tehnička dokumentacija predaju se putem linka navedenog u nastavku.

Predstavljanje:

1. Priprema se kratka prezentacija (7–10 slajdova) koja prikazuje problem, CAD model, CAM proces, CNC obradu i rezultat.
2. Prezentacija treba da sadrži vizualni prikaz rada (slike, simulacije ili video snimak procesa).
3. Prezentacija se dostavlja putem linka navedenog u nastavku.

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Rok za prijavu i predaju:

Sve digitalne datoteke (CAD fajl, CAM projekat, NC kod, tehnička dokumentacija i prezentacija) potrebno je dostaviti najkasnije do _____.

Link za prijavu i predaju materijala:

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

Open Badge se dodeljuje polaznicima koji uspešno završe sve navedene korake i čiji projektni zadatak i prezentacija budu pozitivno ocenjeni.

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Metoda osiguranja kvaliteta

Osiguranje kvaliteta provodi se u skladu s Pravilnikom o sistemu osiguranja kvaliteta kratkih programa obuka sa mikrokreditima (*Open Badge*).....

Short Training Programme *Microcredentials (Open Badge)*

ASSOCIATE IN THE PREPARATION AND IMPLEMENTATION OF EU PROJECTS

Training programme prepared by:

PI Center for Adult Education Banja Luka

Expert team members:

Suzana Kusovac Sladoje
Radojica Sladoje
Dreno Zeljković
Milenko Malinović

Training programme initiators:

Project: *CL_BVET EDUCATION AND TRAINING FOR COLLABORATIVE LEARNING IN BLENDED LEARNING ENVIRONMENTS*

Project partners: Centar za obrazovanje odraslih Banja Luka, JU Tehnička škola Gradiška (Bosnia and Herzegovina), Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna škola Velika Gorica (Croatia), Srednja stručna škola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro).

BASIC INFORMATION ABOUT TRAINING PROGRAMME

Title of training programme:

ASSOCIATE IN THE PREPARATION AND IMPLEMENTATION OF EU PROJECTS

Programme duration:

50 [*hours*]

Credit value:

2 *ECTS*

Educational fields:

• Project management and the project cycle • Economics and financial project planning • Administration and business documentation • Public administration and development programmes • International funds and EU financing programmes • Digital competencies in project management

Awards and certificates:

Upon successful completion of the programme "Associate in the Preparation and Implementation of EU Projects", participants receive a certificate confirming the knowledge, skills, and competencies required for participation in the preparation, development, and implementation of projects funded by the European Union. In addition to the certificate, participants are awarded an Open Badge, which serves as digital proof of the competencies acquired and the learning outcomes achieved. This digital badge enables straightforward verification of knowledge and skills, and may be used on professional networks, electronic CVs, and employment platforms. Together, the certificate and Open Badge confirm the participant's readiness for active participation in the management, coordination, and implementation of projects funded by European Union resources.

1. DESCRIPTION AND TARGET GROUP OF THE TRAINING PROGRAMME

Programme Description:

The programme "Associate in the Preparation and Implementation of EU Projects" qualifies participants to provide professional support in the preparation, development, implementation, and monitoring of projects funded by the European Union, as well as other national and international sources of funding.

The programme enables the acquisition and formalisation of knowledge and skills in the areas of project management, identification of project opportunities, preparation of project proposals, activity and budget planning, and administrative monitoring and reporting on project implementation. Particular emphasis is placed on developing the organisational, communication, and analytical skills necessary for effective work in project teams.

Through the programme, participants acquire practical knowledge of projects, funding rules, documentation management, and the monitoring of project results, enabling them to actively participate in the preparation and implementation of development projects. The competencies acquired contribute to increased employability, professional development, and competitiveness in the labour market, both in the public and private sectors and in other organisations.

Target group:

The programme is intended for unemployed and employed individuals who wish to acquire or enhance their knowledge and skills for working in the preparation and implementation of EU projects in the public, private, and civil sectors.

It is particularly aimed at individuals who wish to increase their employability, formalise existing knowledge, or direct their professional development towards project management and administration.

2. SKILLS

Upon completion of the programme, participants will be qualified to:

- Identify and formulate a project topic
- Develop a financial plan
- Practically develop a project and apply leadership skills
- Demonstrate enhanced communication skills

3. LEARNING OBJECTIVES

Skill 1: **Identifying and Formulating a Project Topic**

Objectives:

- recognise an opportunity and select a project topic;
- explain the significance of the project topic;
- define the problem and justify potential solutions;
- take into account and review previous research on topics in the surrounding environment;
- analyse the call for project applications;
- apply existing knowledge and experience;

Skill 2: **Developing a Financial Plan**

Objectives:

- collect quotations, calls, and procurement notices;
- actively participate in the development of the financial plan;
- adapt the financial plan to the needs of the project;
- adequately analyse losses and costs and record them using appropriate tools (Excel, AI aggregator);

Skill 3**: Practical Project Development and Leadership Skills**

Objectives:

- participate in the preparation and development of project documentation;
- analyse parameters that are relevant to project development;
- carry out a project call in accordance with established procedures;
- complete work assignments on time;
- be prepared for teamwork and collaborative action in pursuit of a shared goal;

Skill 4: **Enhanced Communication Skills**

Objectives:

• maintain communication and cooperation with partners; • organise online meetings with the team; • strive to ensure that communication within the team is conducted in a more open and relaxed manner;

4. PROGRAMME STRUCTURE

No.	Name of Module	Credits (ECTS)	No. hours (h)		
			T	P	TOTAL
1.	Preparation and Development of EU Projects	1	10	15	25
2.	Implementation, Monitoring, and Reporting on EU Projects	1	10	15	25
		TOTAL	**20**	**30**	**50**

MODULE 1: PREPARATION AND DEVELOPMENT OF EU PROJECTS

Objective:
To qualify participants to identify funding opportunities from European Union funds, develop project ideas, and prepare project proposals in accordance with the requirements of public calls and donor programmes.

Content:

- introduction to EU funds and financing programmes;
- fundamentals of the project cycle;
- needs analysis and problem identification;
- project idea development;
- defining project objectives, results, and activities;
- development of the project logical framework;
- project budget planning;
- preparation of project documentation and application forms;
- practical work on the preparation of a project proposal;

Methods:

The module is delivered through a combination of interactive lectures, guided discussions, practical exercises, and work on real-life examples. Participants analyse project ideas, familiarise themselves with project documentation, and develop elements of a project proposal through individual and group assignments. A portion of the activities is delivered online, using digital educational materials and independent study tasks.

MODULE 2: IMPLEMENTATION, MONITORING, AND REPORTING ON EU PROJECTS

Objective:
To qualify participants to support the implementation of EU projects through activity planning, administrative and financial project monitoring, documentation collection, results tracking, and the preparation of reports in accordance with the funder's rules.

Content:

- organisation and management of project activities;
- responsibilities and roles of project team members;
- administrative project monitoring;
- financial monitoring and control of costs and cash flows;
- documenting project activities (activity reports, dissemination);
- monitoring and evaluation of project results;

• preparation of narrative and financial reports;
• visibility and dissemination of project results;
• practical exercises in project management and reporting;

Methods:

The module is delivered through lectures, case studies, practical exercises, and simulations of activities carried out during project implementation. Participants work on examples of administrative and financial project monitoring, the preparation of project documentation, and reports. Instruction is delivered in a combined format, with direct work alongside the instructor and online activities that enable independent learning and assessment of acquired knowledge. Methods include presentations, project work (completion of project assignments), group problem-solving, and reflective activities.

5. METHOD OF DELIVERY

The training programme is delivered in a classroom, in a computer centre, and online.
The programme is delivered in a blended learning format, with a total duration of 50 hours, spread over 10 days at 5 hours per day.

The programme comprises:

- **25 hours** of direct classroom instruction, through lectures, workshops, practical exercises, discussions, and work on real-life examples;
- **25 hours** of guided distance learning (online), via an e-learning platform, through independent study of course materials, task completion, development of project activities, participation in forum discussions, and consultations with the instructor.

By combining direct instruction and guided distance learning, participants are afforded flexible acquisition of knowledge and skills, with continuous instructor support and access to digital educational content throughout the duration of the programme.

Methods of training:

Active learning methods are applied throughout the programme, enabling participants to connect theoretical knowledge with practical application in the field of EU project preparation and implementation. Training includes interactive lectures, demonstrations, guided discussions, case study work, practical exercises, individual and group work, and the completion of project assignments. Within the guided distance learning component, digital educational materials, independent tasks, online consultations, and knowledge assessment and consolidation activities are used. Special emphasis is placed on practical work and the application of acquired competencies to real-life examples from project practice.

6. KNOWLEDGE AND SKILLS ASSESSMENT

The assessment of participants' knowledge and skills is carried out through a practical examination and the defence of a final assignment.

The practical examination assesses the following skills:

- identifying funding opportunities from European Union funds and other sources of financing;
- analysing needs and defining the project idea;
- formulating project objectives, results, and activities;
- developing the basic elements of a project proposal;
- developing the project logical framework;
- planning and preparing the project budget;
- completing basic project documentation;
- organising and monitoring project activities;
- maintaining administrative project documentation;
- monitoring the implementation of project results and indicators;
- preparing narrative reports on project implementation;
- preparing basic financial reports and accompanying documentation;
- applying digital tools in the preparation and implementation of projects.

Through the defence of the final assignment, participants demonstrate their ability to apply acquired knowledge and skills by presenting a developed project proposal or a section of project documentation, and by explaining the key elements of the project.

The practical examination is conducted in three parts:

1. Completion of a project assignment comprising:
- preparation of the basic elements of a project proposal;
- analysis of a given project case and identification of the problem;
- defining objectives, expected results, and target groups;
- activity planning and timeline development;
- preparation of the basic project budget;
- description of the method of implementation and expected project outcomes;

2. Presentation of the development process and results of the project assignment, along with an explanation of the key decisions made in the preparation of the project.

3. Answering questions from the Examination Board to verify understanding of the procedures for preparing, implementing, monitoring, and reporting on EU and other projects.

7. GRADING CRITERIA

The assessment of participants' knowledge and skills is carried out according to the following criteria.
Each criterion is assessed on a scale from 0 to 2 points, with a maximum total score of 14 points [max. 14].

ASSESSMENT CRITERIA:

- Analysis of the project case and clear definition of the problem;
- Formulation of objectives, expected results, and target groups;
- Planning of project activities and the implementation timeline;
- Development and feasibility of the project budget;
- Logical coherence and alignment of the elements of the project proposal (logical framework);
- Knowledge of the procedures for project implementation, monitoring, and reporting;
- Quality of presentation, communication, and responses to questions from Examination Board members;

Each criterion is assessed as follows:

0 – criterion not met
1 – criterion partially met
2 – criterion fully met

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8. CONDITIONS FOR PROGRAMME COMPLETION AND ASSESSMENT OF PERFORMANCE

A participant successfully completes the programme if they achieve a minimum of 8 points out of a possible 14 in the practical examination.

Based on the total number of points achieved, performance is determined as follows:

- **0 – 7 points** – failed
- **8 – 11 points** – passed
- **12 – 14 points** – passed with distinction

Upon completion of the programme, the participant receives a certificate of qualification for working as an associate in the preparation and implementation of EU projects. This is a prerequisite for receiving the microcredential (certificate with Open Badge).

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9. PROCEDURE FOR OBTAINING AN OPEN BADGE

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto
ProjeCt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments
WEB: https://www.cl-bvet.eu/education-and-training/

To receive the Open Badge, participants must successfully complete the training programme and fulfil the following requirements:

- successful attendance and full completion of the training;
- submission of the completed project assignment based on the assigned project case;
- preparation and delivery of a short presentation of the project assignment;
- positive assessment of the project assignment and presentation by the examination board.

The Open Badge is awarded to participants who have demonstrated the competencies acquired in the field of EU project preparation and implementation through practical work and evaluation.

Task Selection:

- The participant selects or is assigned a project case from the field of EU project preparation and implementation.
- The participant develops a project assignment (project documentation) based on the selected case.
- The use of pre-existing or previously completed solutions is not permitted.
- The completed project assignment must be submitted via the link provided below.

Presentation:

- A short presentation (7–10 slides) is prepared, presenting the development process and the key elements of the project assignment.
- The presentation must be submitted via the link provided below.

Submission Deadline:

All digital materials (project assignment and presentation) must be submitted no later than 10 days before the date listed on the Notice Board.

Application and submission link:
https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

The Open Badge is awarded to participants who successfully complete all of the above steps and whose project assignment and presentation receive a positive assessment.

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10. QUALITY ASSURANCE METHODS

QUALITY ASSURANCE IS CARRIED OUT IN ACCORDANCE WITH THE REGULATIONS ON THE QUALITY ASSURANCE SYSTEM FOR SHORT TRAINING PROGRAMMES WITH MICROCREDENTIALS (OPEN BADGE).

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Kratki program osposobljavanja *Microcredentials (Open Badge)*

SARADNIK U PRIPREMI I SPROVOĐENJU EU PROJEKATA

Trening program pripremili:

JU Centar za obrazovanje odraslih Banja Luka

Stručni tim činili:

Suzana Kusovac Sladoje
Radojica Sladoje
Dreno Zeljković
Milenko Malinović

Inicijatori trening programa obuke:

Projekat: ***CL_BVET EDUCATION AND TRAINING FOR COLLABORATIVE LEARNING IN BLENDED LEARNING ENVIRONMENTS***

Partneri na projektu: Centar za obrazovanje odraslih Banja Luka, JU Tehnička škola Gradiška (Bosna i Hercegovina), Šolski center Novo mesto, Euroskill d.o.o. (Slovenija), Srednja strukovna škola Velika Gorica (Hrvatska), Srednja stručna škola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Crna Gora).

OSNOVNE INFORMACIJE O TRENING PROGRAMU

Naslov trening programa:

SARADNIK U PRIPREMI I SPROVOĐENJU EU PROJEKATA

Trajanje programa:

50 [*h*]

Vrjednovanje:

2 *ECTS*

Obrazovna područja:

• Upravljanje projektima i projektnim ciklusom • Ekonomija i finansijsko planiranje projekata • Administracija i poslovna dokumentacija • Javna uprava i razvojni programi • Međunarodni fondovi i EU programi finansiranja • Digitalne kompetencije u projektnom menadžmentu

Dobijena priznanja i sertifikati:

Po uspješnom završetku programa „Saradnik u pripremi i sprovođenju EU projekata“, polaznici stiču sertifikat kojim se potvrđuju znanja, vještine i kompetencije neophodne za učešće u pripremi, izradi i realizaciji projekata finansiranih iz fondova Evropske unije. Pored sertifikata, polaznicima se dodjeljuje i *Open Badge* (otvoreni bedž), koji predstavlja digitalni dokaz stečenih kompetencija i ostvarenih ishoda učenja. Ovaj digitalni bedž omogućava jednostavnu verifikaciju znanja i vještina te se može koristiti na profesionalnim mrežama, elektronskim biografijama i platformama za zapošljavanje. Sertifikat i *Open Badge* zajedno potvrđuju osposobljenost polaznika za aktivno učešće u upravljanju, koordinaciji i sprovođenju projekata finansiranih sredstvima Evropske unije.

1. OPIS I CILJNA GRUPA PROGRAMA OSPOSOBLJAVANJA

Opis programa:

Program „Saradnik u pripremi i sprovođenju EU projekata“ osposobljava polaznike za pružanje stručne podrške u procesu pripreme, izrade, implementacije i praćenja projekata finansiranih iz fondova Evropske unije, kao i drugih nacionalnih i međunarodnih izvora finansiranja.

Program omogućava sticanje i formalizaciju znanja i vještina iz oblasti projektnog menadžmenta, identifikacije projektnih prilika, pripreme projektnih prijedloga, planiranja aktivnosti i budžeta, te administrativnog praćenja i izvještavanja o realizaciji projekata. Poseban akcenat stavlja se na razvoj organizacionih, komunikacionih i analitičkih vještina neophodnih za efikasan rad u projektnim timovima.

Kroz program, polaznici stiču praktična znanja o projektima, pravilima finansiranja, upravljanju dokumentacijom i praćenju projektnih rezultata, što im omogućava aktivno učešće u pripremi i sprovođenju razvojnih projekata. Stečene kompetencije doprinose povećanju zapošljivosti, profesionalnom razvoju i konkurentnosti na tržištu rada, kako u javnom i privatnom sektoru, tako i u drugim organizacijama.

Ciljna grupa:

Program je namjenjen nezaposlenim i zaposlenim licima koja žele da steknu ili unaprijede znanja i vještine za rad na poslovima pripreme i sprovođenja EU projekata u javnom, privatnom i civilnom sektoru.

Posebno je namjenjen osobama koje žele da povećaju svoju zapošljivost, formalizuju postojeća znanja ili se profesionalno usmjere ka poslovima upravljanja i administriranja projekata.

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2. VJEŠTINE

Po završetku programa, polaznik (polaznici) će biti osposobljen (i) za:

- Identifikacija i oblikovanje teme projekta
- Izrada finansijskog plana
- Praktična izrada projekta i vještine vođenja
- Poboljšane komunikacijske vještine

3. CILJEVI UČENJA

Vještina 1: **Identifikacija i oblikovanje teme projekta**

Ciljevi:

- prepoznaje priliku i odabere temu projekta;
- objasni značaj projekte teme;
- definiše problem i obrazloži eventualna rješenja;
- uzme u obzir i razmotri prethodna istraživanja tema u okolini;
- analizira prijedlog poziva za učešće u projektima;
- primjeni dosadašnja znanja i iskustva;

Vještina 2: **Izrada finansijskog plana**

Ciljevi:

- prikuplja ponude i pozive/nabavke;
- aktivno učestvuje u izradi finansijskog plana;
- prilagodi finansijski plan potrebama projekta;
- adekvatno analizira gubitke i troškove bilježi u neki od alata (Excell, AI sumator);

Vještina 3**: Praktična izrada projekta i vještine vođenja**

Ciljevi:

- učestvuje u pripremi i izradi projektne dokumentacije;
- analizira parametre koji su bitni za razvoj projekta;
- sprovodi projektni konkurs u skladu sa procedurama;
- ispunjava radne zadatke na vrijeme;
- spreman za timski rad i zajedničko djelovanje u cilju dostizanja zajedničkog cilja;

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Vještina 4: **Poboljšane komunikacijske vještine**

Ciljevi:

- održava komunikaciju i saradnju sa partnerima;
- organizuje online sastanke sa timom;
- nastoji da se komunikacija unutar tima odvija iskrenije i opuštenije;

4. STRUKTURA PROGRAMA

No.	Naziv modula	Broj bodova (ECTS)	Broj sati (h)		
			T	P	TOTAL
1.	Priprema i izrada EU projekata	1	10	15	25
2.	Sprovođenje, praćenje i izvještavanje o EU projektima	1	10	15	25
		TOTAL	**20**	**30**	**50**

MODUL 1: PRIPREMA I IZRADA EU PROJEKATA

Cilj: Osposobiti polaznike za prepoznavanje mogućnosti finansiranja iz fondova Evropske unije, razvoj projektnih ideja i pripremu projektnih prijedloga u skladu sa zahtjevima javnih poziva i donatorskih programa.

Sadržaj:

- uvod u EU fondove i programe finansiranja;
- osnove projektnog ciklusa;
- analiza potreba i identifikacija problema;
- razvoj projektne ideje;
- definisanje ciljeva, rezultata i aktivnosti projekta;
- izrada logičkog okvira projekta;
- planiranje budžeta projekta;
- priprema projektne dokumentacije i prijavnih obrazaca;
- praktičan rad na pripremi projektnog prijedloga;

Metode:

Modul se realizuje kroz kombinaciju interaktivnih predavanja, vođenih diskusija, praktičnih vježbi i rada na primjerima iz prakse. Polaznici analiziraju projektne ideje, upoznaju se sa projektnom dokumentacijom i kroz individualne i grupne zadatke izrađuju elemente projektnog prijedloga. Dio aktivnosti realizuje se *online* korišćenjem digitalnih obrazovnih materijala i zadataka za samostalni rad.

MODUL 2: SPROVOĐENJE, PRAĆENJE I IZVJEŠTAVANJE O EU PROJEKTIMA

Cilj: Osposobiti polaznike za pružanje podrške u sprovođenju EU projekata kroz planiranje aktivnosti, administrativno i finansijsko praćenje projekta, prikupljanje dokumentacije, praćenje rezultata i pripremu izveštaja u skladu sa pravilima finansijera.

Sadržaj:

- organizacija i upravljanje projektnim aktivnostima;
- odgovornosti i uloge članova projektnog tima;
- administrativno praćenje projekta;
- finansijsko praćenje i kontrola troškova i novčanih tokova;
- dokumentovanje projektnih aktivnosti (*activity report, dissemination*);
- monitoring i evaluacija projektnih rezultata;
- izrada narativnih i finansijskih izveštaja;
- vidljivost i diseminacija projektnih rezultata;
- praktične vježbe iz upravljanja i izvještavanja o projektu;

Metode:

Modul se realizuje kroz predavanja, studije slučaja, praktične vježbe i simulacije aktivnosti koje se sprovode tokom realizacije projekta. Polaznici rade na primjerima administrativnog i finansijskog praćenja projekata, pripremi projektne dokumentacije i izvještaja. Nastava se odvija kombinovano, uz neposredan rad sa predavačem i online aktivnosti koje omogućavaju samostalno učenje i provjeru stečenih znanja. Prezentacije, projektni radovi (izrada projektih zadataka), grupno rješavanje problema, refleksije.

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5. NAČIN REALIZACIJE

Trening program se realizuje u učionici, u računarskom centru i online.

Program se realizuje u kombinovanom načinu učenja (*blended learning*) u ukupnom trajanju od 50 časova, i to 10 dana po 5 časova dnevno.

Program obuhvata:

- **25 časova** neposrednog rada u učionici, kroz predavanja, radionice, praktične vježbe, diskusije i rad na primjerima iz prakse;
- **25 časova** vođenog učenja na daljinu (online), putem platforme za e-učenje, kroz samostalno proučavanje nastavnih sadržaja, rješavanje zadataka, izradu projektnih aktivnosti, učešće u forumskim diskusijama i konsultacije sa predavačem.

Kombinovanjem neposrednog rada i vođenog učenja na daljinu polaznicima se omogućava fleksibilno sticanje znanja i vještina uz kontinuiranu podršku predavača i pristup digitalnim obrazovnim sadržajima tokom cjelokupnog trajanja programa.

Metode obuke:

U realizaciji programa primjenjuju se metode aktivnog učenja koje omogućavaju povezivanje teorijskih znanja sa praktičnom primjenom u oblasti pripreme i sprovođenja EU projekata. Obuka obuhvata interaktivna predavanja, demonstracije, vođene diskusije, rad na studijama slučaja, praktične vježbe, individualni i grupni rad, kao i izradu projektnih zadataka. U okviru vođenog učenja na daljinu koriste se digitalni obrazovni sadržaji, samostalni zadaci, online konsultacije i aktivnosti za provjeru i utvrđivanje stečenih znanja. Poseban naglasak stavlja se na praktičan rad i primjenu stečenih kompetencija na realnim primjerima iz projektne prakse.

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6. PROCJENA ZNANJA I VJEŠTINA

Procjena znanja i vještina realizuje se kroz praktični ispit i odbranu završnog zadatka.

Praktičnim ispitom provjeravaju se **sljedeće vještine**:

- prepoznavanje mogućnosti finansiranja iz fondova Evropske unije i drugih izvora finansiranja;
- analiza potreba i definisanje projektne ideje;
- formulisanje ciljeva, rezultata i aktivnosti projekta;
- izrada osnovnih elemenata projektnog prijedloga;
- izrada logičkog okvira projekta;
- planiranje i izrada budžeta projekta;
- popunjavanje osnovne projektne dokumentacije;
- organizovanje i praćenje projektnih aktivnosti;
- vođenje administrativne dokumentacije projekta;
- praćenje realizacije projektnih rezultata i pokazatelja;
- priprema narativnih izveštaja o realizaciji projekta;
- priprema osnovnih finansijskih izveštaja i prateće dokumentacije;
- primjena digitalnih alata u pripremi i sprovođenju projekata.

Odbranom završnog zadatka polaznik demonstrira sposobnost primjene stečenih znanja i vještina kroz predstavljanje izrađenog projektnog prijedloga ili dijela projektne dokumentacije i obrazlaganje ključnih elemenata projekta.

Praktični ispit odvija se u tri dijela:

1. Izrada projektnog zadatka koji obuhvata:

- pripremu osnovnih elemenata projektnog prijedloga;
- analiza datog projektnog slučaja i identifikacija problema;
- definisanje ciljeva, očekivanih rezultata i ciljnih grupa;
- planiranje aktivnosti i vremenskog okvira;
- izrada osnovnog budžeta projekta;
- opis načina realizacije i očekivanih efekata projekta;

2. Prezentacija procesa izrade i rezultata projektnog zadatka, uz obrazloženje ključnih odluka u pripremi projekta.

3. Odgovaranje na pitanja Komisije radi provjere razumijevanja postupka pripreme, sprovođenja, praćenja i izvještavanja o EU i drugim projektima.

7. KRITERIJUM OCJENJIVANJA

Procjena znanja i vještina polaznika vrši se po sljedećim kriterijumima.

Svaki kriterijum se ocjenjuje u rasponu od **0 do 2 boda**, pri čemu maksimalan broj bodova iznosi **14** [*max. 14*].

KRITERIJUMI OCJENJIVANJA:

- Analiza projektnog slučaja i jasno definisanje problema;
- Formulisanje ciljeva, očekivanih rezultata i ciljnih grupa;
- Planiranje projektnih aktivnosti i vremenskog okvira realizacije;
- Izrada i realističnost budžeta projekta;
- Logička povezanost i usklađenost elemenata projektnog prijedloga (logički okvir);
- Poznavanje postupaka sprovođenja, praćenja i izvještavanja o projektu;
- Kvalitet prezentacije, komunikacija i odgovori na pitanja članova Komisije;

Svaki kriterijum se ocjenjuje na sljedeći način:

0 – kriterijum nije ispunjen
1 – kriterijum je djelimično ispunjen
2 – kriterijum je u potpunosti ispunjen

8. USLOVI ZA ZAVRŠETAK PROGRAMA I USPJEŠNOST RADA

Polaznik uspješno završava program ukoliko na praktičnom ispitu ostvari najmanje 8 bodova od ukupno 14 mogućih bodova.

Na osnovu ukupnog broja ostvarenih bodova, uspjeh se utvrđuje na sljedeći način:
- **0 – 7** bodova – nije položio/la
- **8 – 11** bodova – položio/la
- **12 – 14** bodova – položio/la sa visokim uspehom

Završetkom programa polaznik stiče potvrdu o osposobljenosti za poslove saradnika u pripremi i sprovođenju EU projekata. To je uslov za **dobijanje mikrokredita (sertifikata sa Open Badge).**

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9. POSTUPAK ZA STICANJE OPEN BADGE (*OVORENOG BEDŽA*)

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto
Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments
Poveznica putem web stranice: https://www.cl-bvet.eu/education-and-training/

Za dobijanje *Open Badge* potrebno je da polaznik uspješno završi program obuke i ispuni sljedeće uslove:

- uspješno pohađanje i završetak obuke u cjelini
- predaja izrađenog projektnog zadatka prema zadatom projektnom slučaju
- priprema i izvođenje kratke prezentacije projektnog zadatka
- pozitivna ocjena projektnog zadatka i prezentacije od strane komisije

Open Badge se dodeljuje polaznicima koji su dokazali stečene kompetencije u oblasti pripreme i sprovođenja EU projekata kroz praktičan rad i evaluaciju.

Izbor zadatka:

1. Polaznik bira zadati projektni slučaj iz oblasti pripreme i sprovođenja EU projekata.
2. Izrađuje projektni zadatak (projektnu dokumentaciju) na osnovu izabranog slučaja.
3. Nije dopuštena upotreba već postojećih ili ranije izrađenih rešenja.
4. Gotov projektni zadatak se predaje putem linka navedenog u nastavku.

Predstavljanje:

1. Priprema se kratka prezentacija (7–10 slajdova) koja prikazuje proces izrade i ključne elemente projektnog zadatka.
2. Prezentacija se dostavlja putem linka navedenog u nastavku.

Rok za prijavu i predaju:

• Svi digitalni materijali (projektni zadatak i prezentacija) moraju biti dostavljeni najkasnije 10 dana prije datuma predvidjenog na Oglasnoj tabli.

Link za prijavu i predaju materijala:
https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

Open Badge se dodeljuje polaznicima koji uspešno završe sve navedene korake i čiji projektni zadatak i prezentacija budu pozitivno ocenjeni.

10. METODE OSIGURANJA KVALITETA

OSIGURANJE KVALITETA PROVODI SE U SKLADU S PRAVILNIKOM O SISTEMU OSIGURANJA KVALITETA KRATKIH PROGRAMA OBUKA SA MIKROKREDITIMA (*OPEN BADGE*).

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Short training program Microcredentials (Open Badge)

Digital tools for effective project management

The training program was prepared by

School center Novo mesto

Experts:

Urban Mihelčič

Providers of the educational program

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Project partners: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna skola Velika Gorica (Croatia), Tehnicka skola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja strucna skola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro)

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Basic information about the training program

Title of the training programme:

Digital Tools for Effective Project Management

Duration of the training program:

25 hours

Credits:

1 credit point ECTS

Educational areas:

Computer science, digital tools, communication

Certificates and badges obtained:

Upon successful completion of the training, the participant receives a certificate of completion with a list of acquired competencies. The participant also receives a digital open badge describing the achieved learning outcomes required to earn the badge.

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1. Description and target group of the training programme:

Program Description

Participants will learn to use digital tools such as Google Drive for document management and MS Teams, Trello, and Asana for task organization and progress tracking. Special emphasis will be placed on effective team communication, which ensures transparency, collaboration, and the successful implementation of projects.

Target group

The training program is intended for everyone who wishes to improve their project management skills in a modern remote working environment.

2. Competence

Through the training, the participant (s) develops the following professional competences:

- Communication and collaboration in remote environments
- Use of digital tools for project work (Trello, Asana, etc.)
- Use of cloud solutions (Google Drive / OneDrive)
- Organization and transparency of the digital working environment
- Independence and responsibility in a virtual team

3. Learning objectives

Competence: **Communication and collaboration in remote environments**

Participant(s)

- Explains the importance of effective communication and collaboration in virtual teams
- Defines roles, responsibilities, and collaboration rules in a digital project environment,
- Selects appropriate communication channels according to purpose and target audience,
- Performs collaborative tasks in an online environment (online meetings, group work),
- Adheres to the principles of digital ethics, professional communication, and safe use of digital tools.

Competence: **Use of digital tools for project work (Trello, Asana, etc.)**

Participant(s)

- Creates a project board with a clear structure of tasks, phases, and responsibilities,
- Adapts the project environment according to project needs and team size,
- Transforms project goals into operational tasks and timelines,
- Configures and uses tool functionalities for progress tracking and reporting.

Competence: **Use of cloud solutions (Google Drive / OneDrive)**

Participant(s)

- Prepares and sets up a folder structure for project documentation in the cloud,
- Analyzes document access requirements and assigns appropriate permissions,
- Carries out collaborative creation, sharing, and real-time co-editing of documents,
- Maintains well-organized, transparent, and secure digital project documentation.

Competence: **Organization and transparency of the digital working environment**

Participant(s)

- Explains the importance of a well-structured digital working environment for successful project work,
- Defines basic rules for organizing files, tools, and communication channels,
- Selects an appropriate structure of digital tools according to project needs,
- Establishes and optimizes a digital environment for efficient work,
- Analyzes document access requirements and assigns appropriate permissions.

Competence: **Independence and responsibility in a virtual team**

Participant(s)

- Explains the importance of independent work and personal responsibility in a virtual team,
- Defines own tasks, deadlines, and responsibilities within the project process,
- Carries out assigned tasks in accordance with agreed rules and timelines,
- Adheres to principles of responsible conduct, reliability, and a collaborative culture.

4. Structure of the training programme

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No.	MODULE NAME	NUMBER OF POINTS KT (ECTS)	Number of hours (h)		
			T	PW	TOTAL
1.	Introduction to Digital Project Work	0,2	2	3	5
2.	Project Management Tools	0,2	2	3	5
3.	Cloud and Documents	0,2	2	3	5
4.	Communication and Collaboration	0,2	2	3	5
5.	Final Project	0,2	1	4	5
		TOTAL	**9**	**16**	**25**

Module 1: Introduction to Digital Project Work

Objectives:
Participants become familiar with the basic characteristics of digital project work, the challenges and advantages of remote work, and an overview of key digital tools for project management.

Content:

- Challenges and opportunities of remote work
- Overview of digital tools for project work
- Basic rules of communication and collaboration in virtual teams

Methods: explanation and guided discussion (in-person), presentation of good practice examples, short reflective tasks (remote), individual work, and discussion.

Module 2: Project Management Tools

Objectives:
Participants develop the ability to effectively use digital tools for planning, organizing, and monitoring project tasks.

Content:

- Organization of tasks, deadlines, and responsibilities (Trello, Asana, etc.)
- Use of spreadsheets and reports
- Practical exercises: setting up a project board

Methods: demonstration of tool usage (in person or online), guided hands-on exercises on the computer, work in small groups (in person), and independent tasks in an online environment.

Module 3: Cloud and Documents

Objectives:
Participants acquire knowledge for managing, sharing, and collaboratively editing project documentation in cloud-based environments.

Content:

- Google Drive / OneDrive: creation, sharing, and access management
- Collaborative document editing and use of comments
- Folder organization and document transparency
- Practical exercises in pairs or groups

Methods: explanation with demonstration (in person), practical work in pairs or groups, collaborative work in the cloud (remote), and tasks for knowledge consolidation.

Module 4: Communication and Collaboration

Objectives:
Participants develop skills for effective digital communication and collaboration in virtual project teams.

Content:

- Effective use of Zoom / Teams / Slack
- Organization of virtual meetings
- Good practices for feedback and remote collaboration
- Simulation of an online meeting

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Methods: online meeting simulations (in person and online), role-playing activities, group discussions and reflection, and collaborative remote tasks.

Module 5: Final Project

Objectives:
Participants independently or in groups apply the acquired knowledge to implement a mini-project and reflect on their own work and collaboration in a digital environment.

Content:

- Design of a mini-project (project board + cloud folder structure + communication plan)
- Presentation of the project to the team
- Feedback and reflection

Methods: project-based work (partly in person and partly remote), individual and group work, project presentations (in person or online), evaluation, and feedback.

5. Method of execution

The training is carried out in a combined workshop and online classroom:

- **1 day** live 2 **Hours**
- **2 day** live 2 **Hours**
- **3 day** live 2 **hours**
- **4 day** live 2 **hours**
- **Work in an online classroom** (videos, problem tasks, forum, creation and submission of an independent project) – 12 **Hours**
- **5 day** live in the workshop - presentation of independent projects and evaluation - 5 **Hours.**

Teaching methods: explanation, discussion, problem-based learning, practical exercises, project assignment.

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6. Assessment of knowledge

The assessment of knowledge is carried out by means of a practical test and a defence. With a practical test, all X competencies of the program are checked:

- Quiz (basic tools, principles of collaboration)
- Practical tasks (creating a project board, working in Google Drive, conducting an online meeting)
- Case study (selection of appropriate tools based on a given scenario)
- Final project (mini-project with all required elements, presentation and peer review)

The practical test takes place in three parts:

1. Making a product
2. presentation of the process and results**,**
3. defence before the Commission**.**

1. Product production (digital + physical part)

- Establishment of a project board in a digital tool (e.g. Trello or Asana),
- Preparation and organization of project documentation in a cloud environment (Google Drive / OneDrive),
- Definition of tasks, deadlines, responsibilities, and communication rules,
- Demonstration of collaboration and independent work within a virtual project team.

(Digital part: project board, cloud-based documents; physical part: project structure, project concept, or a project workflow diagram.)

2. Presentation of the process and results

The candidate prepares a short presentation (5-7 minutes**)** demonstrating:

- the selected project problem and the objectives of the mini-project,
- the digital tools used and the reasons for their selection,
- the workflow, task distribution, and mode of collaboration,
- the achieved results and a personal reflection on the acquired knowledge.

3. Defense

- The committee asks the candidate questions about the procedure, selected solutions, and possible improvements.
- The candidate answers the questions by explaining their understanding of the fundamentals of digital project management, remote collaboration, and the use of digital tools.

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Evaluation criteria:

1. Appropriateness of the selection and use of digital tools (0–2 points)
2. Organization and clarity of project work (0–2 points)
3. Use of cloud solutions and document management (0–2 points)
4. Digital communication and team collaboration (0–2 points)
5. Independence and responsibility in task execution (0–2 points)
6. Quality and completeness of the product (0–2 points)
7. Presentation and defence (0–2 points)

Rating formatting:

- 0-6 points: insufficient
- 7-10 points: good
- 11-14 points: excellent

To obtain microproof: min. 7 points (min. good), none of the criteria should be evaluated with 0 points.

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Open Badge

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Link via website: https://www.cl-bvet.eu/education-and-training/

To obtain the Open Badge -Digital tools for effective project management it is necessary to successfully complete the training. It is necessary to submit a project assignment and a short presentation. The project assignment and presentation must be successfully evaluated.

Task selection:

• The use of pre-existing solutions is not permitted. • Submit at the link below.

Presentation:

• Prepare a short presentation (2-3 pages) • Submit your presentation at the link below.

Submission date:

1.	**Upload digital files and presentations at the link below no later than .....**

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

7. Quality assurance method

Quality assurance is carried out in accordance with the Rules on the Quality Assurance System for Short Programmes with Micro-Evidence …….

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Kratki program usposabljanja Microcredentials (Open Badge)

Digitalna orodja za učinkovito vodenje projektov

Program usposabljanja so pripravili

Šolski center Novo mesto

Strokovnjaki:

Urban Mihelčič

Izvajalci izobraževalnega progama

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Projektni partnerji: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna skola Velika Gorica (Croatia), Tehnicka skola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja strucna skola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro)

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Osnovni podatki o programu usposabljanja

Naziv programa usposabljanja:

Digitalna orodja za učinkovito vodenje projektov

Trajanje programa usposabljanja :

25 ur

Kreditne točke:

1 KT

Izobraževalni področji:

Računalništvo, digitalna orodja, komunikacija

Pridobljena potrdila in značke:

Udeleženec ob uspešnem zaključku prejme potrdilo o izvedenem izobraževanju z izpisom pridobljenih kompetenc. Udeleženec prejeme digitalno odprto značko z opisom doseženih učnih izidov, ki jih je dosegel, da je značko pridobil.

1. **Opis in ciljna skupina programa usposabljanja:**

Opis programa

Udeleženci se bodo naučili uporabljati digitalna orodja, kot so Google Drive za upravljanje dokumentov ter MS Teams/Trello/Asana za organizacijo nalog in spremljanje napredka. Poseben poudarek bo na učinkoviti komunikaciji v timu, ki zagotavlja preglednost, sodelovanje in uspešno izvedbo projektov.

Ciljna skupina

Program usposabljanja je namenjen vsem, ki želijo izboljšati svoje veščine projektnega vodenja v sodobnem okolju dela na daljavo.

2. **Kompetence**

Z usposabljanjem udeleženec (ka) razvija naslednje poklicne kompetence:

Komunikacija in sodelovanje na daljavo Uporaba digitalnih orodij za projektno delo (Trello, Asana ipd.) Uporaba oblačnih rešitev (Google Drive/OneDrive) Organizacija in preglednost digitalnega okolja Samostojnost in odgovornost v virtualnem timu

3. **Učni cilji**

Kompetenca: Komunikacija in sodelovanje na daljavo

Udeleženec (ka)

- Pojasni pomen učinkovite komunikacije in sodelovanja v virtualnih timih,
- opredeli vloge, odgovornosti in pravila sodelovanja v digitalnem projektnem okolju,
- izbere ustrezne komunikacijske kanale glede na namen in ciljno skupino,
- opravi sodelovalne naloge v spletnem okolju (spletni sestanki, skupinsko delo),
- upošteva načela digitalne etike, profesionalne komunikacije in varne rabe orodij.

Kompetenca: Uporaba digitalnih orodij za projektno delo (Trello, Asana, ipd.)

Udeleženec (ka)

- Izdela projektno tablo z jasno strukturo nalog, faz in odgovornosti,
- prilagodi projektno okolje glede na potrebe projekta in velikost tima,
- pretvori cilje projekta v operativne naloge in časovne roke,
- nastavi in uporablja funkcionalnosti orodij za spremljanje napredka in poročanje.

Kompetenca: Uporaba oblačnih rešitev (Google Drive/OneDrive)
Udeleženec (ka)

- pripravi in nastavi strukturo map za projektno dokumentacijo v oblaku,
- analizira potrebe po dostopu do dokumentov in določi ustrezne pravice,
- izvede skupinsko ustvarjanje, deljenje in sočasno urejanje dokumentov,
- vzdržuje urejeno, pregledno in varno digitalno dokumentacijo projekta.

Kompetenca: Organizacija in preglednost digitalnega okolja
Udeleženec (ka)

- pojasni pomen preglednega digitalnega delovnega okolja za uspešno projektno delo,
- opredeli osnovna pravila organizacije datotek, orodij in komunikacijskih kanalov,
- izbere ustrezno strukturo digitalnih orodij glede na projektne potrebe,
- opravi vzpostavitev in optimizacijo digitalnega okolja za učinkovito delo.
- analizira potrebe po dostopu do dokumentov in določi ustrezne pravice,

Kompetenca: Samostojnost in odgovornost v virtualnem timu
Udeleženec (ka)

- pojasni pomen samostojnega dela in osebne odgovornosti v virtualnem timu,
- opredeli lastne naloge, roke in odgovornosti v projektnem procesu,
- izvede dodeljene naloge skladno z dogovorjenimi pravili in časovnimi okvirji,
- upošteva načela odgovornega ravnanja, zanesljivosti in sodelovalne kulture.

4. Struktura programa usposabljanja

Z. št.	IME MODULA	ŠTEVILO TOČK KT (ECTS)	UR (h)		
			T	PP	SKUPNO
1.	Uvod v digitalno projektno delo	0,2	2	3	5
2.	Projektna orodja	0,2	2	3	5
3.	Oblak in dokumenti	0,2	2	3	5
4.	Komunikacija in sodelovanje	0,2	2	3	5
5.	Zaključni projekt	0,2	1	4	5
		SKUPNO	**9**	**16**	**25**

Modul 1: Uvod v digitalno projektno delo

Cilji:
Udeleženci spoznajo osnovne značilnosti digitalnega projektnega dela, izzive in prednosti dela na daljavo ter pregled ključnih digitalnih orodij za projektno vodenje.

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Vsebina:

- Izzivi in priložnosti dela na daljavo
- Pregled digitalnih orodij za projekte
- Osnovna pravila komunikacije in sodelovanja v virtualnih timih

Metode: razlaga in voden pogovor (v živo), predstavitev primerov dobrih praks, kratke refleksijske naloge (na daljavo), individualno delo in razprava.

Modul 2: Projektna orodja

Cilji:
Udeleženci razvijejo sposobnost učinkovite uporabe digitalnih orodij za načrtovanje, organizacijo in spremljanje projektnih nalog.

Vsebina:

- Organizacija nalog, rokov in odgovornosti (Trello, Asana ipd.)
- Uporaba preglednic in poročil
- Praktične vaje: vzpostavitev projektne table

Metode: demonstracija uporabe orodij (v živo ali online), vodene praktične vaje na računalniku, delo v manjših skupinah (v živo), samostojne naloge v spletnem okolju.

Modul 3: Oblak in dokumenti

Cilji:
Udeleženci osvojijo znanja za upravljanje, deljenje in sodelovalno urejanje projektne dokumentacije v oblačnih okoljih.

Vsebina:

- Google Drive/OneDrive: ustvarjanje, deljenje in upravljanje dostopov
- Sodelovalno urejanje dokumentov in uporaba komentarjev
- Organizacija map in preglednost dokumentov
- Praktične vaje v parih/skupinah

Metode:

razlaga z demonstracijo (v živo), praktično delo v parih ali skupinah, sodelovalno delo v oblaku (na daljavo), naloge za utrjevanje znanja.

Modul 4: Komunikacija in sodelovanje

Cilji:
Udeleženci razvijejo veščine učinkovite digitalne komunikacije in sodelovanja v virtualnih projektnih timih.

Vsebina:

- Učinkovita uporaba Zoom/Teams/Slack
- Organizacija virtualnih sestankov
- Dobre prakse povratnih informacij in sodelovanja na daljavo
- Simulacija online sestanka

Metode: simulacije spletnih sestankov (v živo in online), igranje vlog (role-play), skupinske razprave in refleksija, sodelovalne naloge na daljavo.

Modul 5: Zaključni projekt

Cilji:
Udeleženci samostojno ali v skupini uporabijo pridobljena znanja za izvedbo mini-projekta in reflektirajo lastno delo ter sodelovanje v digitalnem okolju.

Vsebina:

- Oblikovanje mini-projekta (projektna tabla + struktura map v oblaku + komunikacijski načrt)
- Predstavitev projekta ekipi
- Povratne informacije in refleksija

Metode: projektno delo (deloma v živo, deloma na daljavo), samostojno in skupinsko delo, predstavitev projektov (v živo ali online), vrednotenje in povratna informacija.

5. Način izvedbe

Usposabljanje se izvaja kombinirano v delavnici in spletni učilnici:

- **1 dan** v živo 2 **uri**
- **2 dan** v živo 2 **uri**

- **3 dan** v živo 2 **uri**
- **4 dan** v živo 2 **uri**
- **Delo v spletni učilnici** (videoposnetki, problemske naloge, forum, izdelava in oddaja samostojnega projekta) – 12 **ur**
- **5 dan** v živo v delavnici – izdelava in predstavitev samostojnih projektov in ocenjevanje - 5 **ur.**

Metode poučevanja: razlaga, diskusija, problemsko učenje, praktične vaje, projektna naloga.

6. Ocenjevanje znanja

Ocenjevanje znanja se izvede z praktičnim preizkusom in zagovorom.
Z praktičnim preizkusom se preverjajo vse kompetence programa:

- Kviz (osnovna orodja, načela sodelovanja)
- Praktične naloge (ustvarjanje projektne table, delo v Google Drive, izvedba online sestanka)
- Študija primera (izbira ustreznih orodij glede na scenarij)
- Zaključni projekt (mini-projekt z vsemi elementi, predstavitev + peer review)

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Praktični preizkus poteka v treh delih:

1. izdelava izdelka**,**
2. predstavitev procesa in rezultatov**,**
3. zagovor pred komisijo**.**

1. Izdelava izdelka (digitalni + fizični del)

Udeleženec izdela mini projekt s področja digitalnega projektnega dela, ki vključuje:

- vzpostavitev projektne table v digitalnem orodju (npr. Trello ali Asana),
- pripravo in organizacijo projektne dokumentacije v oblačnem okolju (Google Drive / OneDrive),
- opredelitev nalog, rokov, odgovornosti in komunikacijskih pravil,
- prikaz sodelovanja in samostojnega dela v virtualnem projektnem timu.

(Digitalni del: projektna tabla, dokumenti v oblaku; fizični del: struktura, koncept projekta ali shema projektnega poteka.)

2. Predstavitev procesa in rezultatov

- Kandidat pripravi **kratko predstavitev (5–7 minut)**, kjer prikaže:

- Kandidat pripravi kratko predstavitev (5–7 minut), v kateri prikaže:
- izbrani projektni problem in cilje mini-projekta,
- uporabljena digitalna orodja in razloge za njihovo izbiro,
- potek dela, razdelitev nalog in način sodelovanja,
- dosežene rezultate in osebno refleksijo pridobljenih znanj.

3. Zagovor

- Komisija dijaku postavi vprašanja o postopku, izbranih rešitvah in možnih izboljšavah.
- Kandidat odgovarja na vprašanja, pri katerih pojasni razumevanje osnov digitalnega projektnega vodenja, sodelovanja na daljavo ter uporabe digitalnih orodij.

Kriteriji ocenjevanja:

- Ustreznost izbire in uporabe digitalnih orodij (0–2 točki)
- Organizacija in preglednost projektnega dela (0–2 točki)
- Uporaba oblačnih rešitev in delo z dokumenti (0–2 točki)
- Digitalna komunikacija in sodelovanje v timu (0–2 točki)
- Samostojnost in odgovornost pri izvedbi nalog (0–2 točki)
- Kakovost in celovitost izdelka (0–2 točki)
- Predstavitev in zagovor (0–2 točki)

Oblikovanje ocene:

- 0–6 točk: nezadostno
- 7–10 točk: dobro
- 11–14 točk: odlično

Za pridobitev mikrodokazila: min. 7 točk (min. dobro), nobeden od kriterijev ne sme biti ocenjen z 0 točkami.

Dostop do Open Badge –

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Povezava preko spletne strani: https://www.cl-bvet.eu/education-and-training/

Za pridobitev Open Badge - Digitalna orodja za učinkovito vodenje projektov je potrebno uspešno zaključiti usposabljanje. Oddati je potrebno projektno nalogo in kratko prezentacijo. Projektna naloga in prezentacija morata biti uspešno ocenjena.

Izbira naloge:

- Uporaba že obstoječih rešitev ni dovoljena.
- Oddajte na spodnji povezavi.

Predstavitev:

- Pripravite kratko predstavitev (2-3 strani)
- Predstavitev oddajte na spodnji povezavi.

Rok oddaje:

- **Digitalne datoteke in predstavitve naložite na spodnji povezavi najkasneje do**

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

7. Način zagotavljanja kakovosti

Zagotavljaje kakovosti se izvede skladno s Pravilnik o sistemu zagotavljanja kakovosti za kratke programe z mikrodokazili

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Kratki program usposabljanja Microcredentials (Open Badge)

Osnove digitalne industrijske avtomatizacije s PLK

Program usposabljanja so pripravili

Šolski center Novo mesto,
Srednja elektro-računalniška šola in tehniška gimnazija

Strokovnjaki:

Marko Simčič

Izvajalci izobraževalnega progama

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Projektni partnerji: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna skola Velika Gorica (Croatia), Tehnicka skola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja strucna skola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro)

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Osnovni podatki o programu usposabljanja

Naziv programa usposabljanja:

Osnove digitalne industrijske avtomatizacije s PLK

Trajanje programa usposabljanja :

50 ur

Kreditne točke:

2 KT

Izobraževalni področji:

Elektrotehnika, mehatronika

Pridobljena potrdila in značke:

Udeleženec, ki uspešno zaključi program usposabljanja, pridobi **uradno potrdilo o opravljenem izobraževanju** ter **digitalno odprto značko (Open Badge)**, ki potrjuje pridobljene kompetence s področja osnov programiranja in uporabe programirljivih logičnih krmilnikov (PLK). Odprta značka vsebuje preverljive podatke o: • nosilcu značke, • izvajalcu izobraževanja, • vsebini in obsegu usposabljanja (50 ur, 2 KT), • pridobljenih kompetencah, • načinu preverjanja znanja (praktični preizkus in zagovor). Značka dokazuje, da je imetnik sposoben: • razviti in preizkusiti enostaven PLK-program, • povezati PLK z vhodno-izhodnimi napravami, • uporabiti osnovna orodja za testiranje in diagnostiko, • razumeti in uporabiti tehnično dokumentacijo, • sodelovati pri reševanju tehničnih nalog v avtomatiziranem okolju. Odprta značka je izdana v digitalni obliki in je prenosljiva ter preverljiva na mednarodnih platformah (npr. Open Badge Factory), zato jo lahko udeleženec uporabi v življenjepisu, na LinkedInu ali pri dokazovanju kompetenc delodajalcem in izobraževalnim ustanovam. Potrdilo in značka skupaj predstavljata uraden in zaupanja vreden dokaz o uspešno pridobljenih strokovnih kompetencah s področja industrijske avtomatizacije in PLK.

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1. **Opis in ciljna skupina programa usposabljanja:**

Opis programa

Program *Osnove programiranja programirljivih logičnih krmilnikov (PLK)* je kratko, praktično usmerjeno izobraževanje, namenjeno pridobivanju temeljnih znanj s področja industrijske avtomatizacije. Udeleženci spoznajo vlogo in zgradbo PLK ter se usposobijo za osnovno programiranje z uporabo standardnih programskih jezikov (LAD, FBD). Program poudarja praktično delo, reševanje enostavnih industrijskih primerov ter testiranje in osnovno diagnostiko PLK-programov.

Ciljna skupina

Program usposabljanja je namenjen dijakom, študentom in odraslim udeležencem, ki se izobražujejo ali delujejo na področju elektrotehnike, mehatronike, strojništva ali sorodnih tehničnih področij. Primeren je za začetnike na področju industrijske avtomatizacije, ki želijo pridobiti osnovna znanja programiranja programirljivih logičnih krmilnikov (PLK), ter za zaposlene v industriji, ki potrebujejo temeljno razumevanje delovanja in programiranja PLK za opravljanje svojih delovnih nalog. Program je primeren tudi za vse, ki se želijo dodatno usposobiti ali nadgraditi svoje kompetence za delo v avtomatiziranih in digitaliziranih proizvodnih okoljih.

2. **Kompetence**

Z usposabljanjem udeleženec (ka) razvija naslednje poklicne kompetence:

Kompetence pridobljene po programu usposabljanja (3-5)
1. Osnovno programiranje PLK **2. Uporaba PLK v avtomatiziranih sistemih** **3. Testiranje in osnovna diagnostika PLK-programov** **4. Branje in uporaba tehnične dokumentacije** **5. Reševanje tehničnih problemov v timu**

3. **Učni cilji**

Kompetenca: **Osnovno programiranje PLK**

Udeleženec (ka)

• Pojasni vlogo programirljivih logičnih krmilnikov (PLK) v avtomatiziranih procesih ter osnovna načela delovanja PLK-krmiljenja. • Opredeli osnovne komponente PLK-sistema (strojna oprema, vhodi/izhodi, programsko okolje) in njihovo funkcijo v krmilnem sistemu. • Izbere ustrezen osnovni programski jezik in programske elemente (npr. LAD, FBD, logične funkcije, časovnike) glede na zahteve enostavne krmilne naloge.

- Opravi izdelavo enostavnega PLK-programa za krmiljenje osnovnega avtomatiziranega procesa ter program preizkusi v simulacijskem ali realnem okolju.
- Upošteva osnovna pravila strukturiranega programiranja, varnosti, berljivosti kode ter osnovne tehnične in industrijske standarde.

Kompetenca: **Uporaba PLK v avtomatiziranih sistemih**

Udeleženec (ka)

- Izdela osnovno krmilno rešitev z uporabo PLK za enostaven avtomatiziran proces na podlagi danih funkcionalnih zahtev.
- Prilagodi PLK-program in nastavitve sistema glede na spremembe v procesu, uporabljene senzorje ali aktuatorje.
- Pretvori logični opis ali shemo avtomatiziranega procesa (npr. funkcijski opis, zaporedje delovanja) v delujoč PLK-program.
- Nastavi vhodno-izhodne parametre, komunikacijske nastavitve in osnovne sistemske parametre za pravilno delovanje PLK v avtomatiziranem sistemu.

Kompetenca: **Testiranje in osnovna diagnostika PLK-programov**

Udeleženec (ka)

- Pripravi in nastavi testno okolje za preverjanje delovanja PLK-programa, vključno z uporabo simulacijskih orodij ter osnovnih diagnostičnih funkcij razvojnega okolja.
- Analizira delovanje PLK-programa in odzive sistema na vhodne signale ter prepozna enostavne logične, funkcijske ali povezovalne napake.
- Izvede postopke testiranja, preverjanja in odpravljanja osnovnih napak v PLK-programu ter potrdi pravilno delovanje krmilnega procesa.
- Vzdržuje zanesljivo delovanje PLK-programa z osnovnimi prilagoditvami, posodobitvami in dokumentiranjem izvedenih sprememb.

Kompetenca: **Branje in uporaba tehnične dokumentacije**

Udeleženec (ka)

- Razume strukturo in vsebino tehnične dokumentacije za PLK.
- Interpretira električne in funkcijske sheme.
- Uporabi dokumentacijo za konfiguracijo in programiranje PLK.
- Preveri skladnost izvedbe z dokumentacijo.
- Upošteva veljavne standarde in varnostne zahteve.

Kompetenca: **Reševanje tehničnih problemov v timu**

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Udeleženec (ka)

- Sodeluje pri reševanju tehničnih nalog v timu.
- Komunicira tehnične rešitve in težave z drugimi člani tima.
- Prispeva k skupnemu načrtu in izvedbi PLK-rešitve.
- Sprejema povratne informacije in jih uporabi za izboljšave.
- Upošteva dogovorjene postopke in varnostna pravila.

4. Struktura programa usposabljanja

Z. št.	IME MODULA	ŠTEVILO TOČK KT (ECTS)	UR (h)		
			T	PP	SKUPNO
1.	Modul 1: Osnove PLK in programiranja	1	7	18	25
2.	Modul 2: Uporaba in diagnostika PLK v avtomatiziranih sistemih	1	7	18	25
		SKUPNO	**14**	**36**	**50**

Modul 1: Osnove PLK in programiranja

Cilji:
Udeleženci osvojijo temeljno razumevanje vloge in delovanja programirljivih logičnih krmilnikov v avtomatiziranih sistemih. Pridobijo osnovna znanja o zgradbi PLK ter se usposobijo za izdelavo enostavnih PLK-programov z uporabo osnovnih programskih jezikov (LAD, FBD). Razvijejo sposobnost logičnega razmišljanja in razumevanja osnovnih krmilnih algoritmov.

Vsebina:

- Vloga PLK v avtomatizaciji.
- Zgradba PLK (strojna oprema, I/O)
- Osnovni programski jeziki (LAD, FBD)
- Enostavni krmilni algoritmi.

Metode: Razlaga s primeri iz prakse, video demonstracije osnovnih PLK-konceptov in programiranja, vodene vaje na računalniku (PLK-simulacija), reševanje kratkih strukturnih nalog, samostojno delo z uporabo učnih gradiv.

Modul 2: Uporaba in diagnostika PLK v avtomatiziranih sistemih

Cilji:
Udeleženci osvojijo praktične spretnosti za uporabo PLK v enostavnih avtomatiziranih procesih. Usposobijo se za povezovanje PLK s senzorji in aktuatorji, testiranje delovanja programov ter osnovno diagnostiko in odpravljanje napak. Razvijejo sposobnost uporabe tehnične dokumentacije in sodelovanja pri reševanju praktičnih industrijskih primerov.

Vsebina:

- Povezovanje PLK s senzorji, stikali, tipkami, aktuatorji
- Testiranje in osnovna diagnostika
- Uporaba dokumentacije
- Reševanje praktičnih problemov

Metode: praktično delo s PLK-simulatorjem ali fizično opremo, problemske in projektne naloge iz industrijske prakse, delo v manjših skupinah (timsko reševanje nalog), demonstracije testiranja in diagnostike PLK-programov, refleksija in analiza izvedenih rešitev s povratno informacijo.

5. Način izvedbe

Usposabljanje se izvaja kombinirano v delavnici in spletni učilnici:

- **1 dan** v živo 4 **ur**
- **2 dan** v živo 4 **ur**
- **3 dan** v živo 4 **ur**
- **4 dan** v živo 4 **ur**
- **5 dan** v živo 4 **ur**
- **6 dan** v živo 4 **ur**
- **7 dan** v živo 4 **ur**
- **8 dan** v živo 4 **ur**
- **9 dan** v živo 4 **ur**
- **10 dan** v živo 4 **ur**
- **Delo v spletni učilnici** (videoposnetki, problemske naloge, forum, izdelava in oddaja samostojnega projekta) – 6 **ur**
- **5 dan** v živo v delavnici - predstavitev samostojnih projektov in ocenjevanje - **4 ur.**

Metode poučevanja: razlaga, diskusija, problemsko učenje, praktične vaje, projektna naloga.

6. Ocenjevanje znanja

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Ocenjevanje znanja se izvede z praktičnim preizkusom in zagovorom.
Z praktičnim preizkusom se preverjajo vse kompetence programa:

- **Projektna naloga**
  Udeleženec dobi realno ali simulirano industrijsko nalogo, npr.:
  - krmiljenje transportnega traku,
  - avtomatska vrata,
  - polnilna linija,
  - semafor s tipkami in časovniki.

  Pri tem mora:
  - zasnovati logiko,
  - napisati PLK-program,
  - povezati vhode in izhode,
  - sistem preizkusiti in popraviti napake.

  S tem neposredno preverjamo: programiranje, uporabo PLK, diagnostiko in razumevanje procesa.

  *To je za Open Badge in mikrodokazila **najmočnejši dokaz kompetenc**.*

- **Opazovanje med praktičnim delom**
  Mentor ali komisija spremlja udeleženca med delom:
  - ali zna samostojno reševati napake,
  - ali razume, kaj dela,
  - ali zna uporabljati razvojno okolje.

  *To ni le končni izdelek, ampak **proces dela**.*

- **Kratek tehnični zagovor**
  Po projektu udeleženec razloži:
  - zakaj je izbral takšno logiko,
  - kako deluje njegov program,
  - kaj bi izboljšal.

  Komisija mu postavi vprašanja tipa:
  - Kaj se zgodi, če senzor odpove?
  - Zakaj ste uporabili ta časovnik?
  - Kako bi to prilagodili za drug proces?

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*To preverja **razumevanje**, ne samo mehansko uporabo.*

- **Mini kviz ali preverjanje znanja (opcijsko podporno orodje)**
  Lahko uporabiš kratek spletni ali pisni kviz za:
  - osnovne pojme (I/O, LAD, FBD, časovniki),
  - branje shem,
  - varnost.

  To ni glavno ocenjevanje, ampak:
  filter, da vidiš ali razume osnove, preden gre na projekt.

- **Tehnična dokumentacija kot dokaz**
  Udeleženec mora oddati:
  - opis delovanja,
  - shemo ali seznam I/O,
  - kratko razlago programa.

  To pokaže:
  - ali zna dokumentirati rešitev,
  - ali razume industrijske standarde.

Praktični preizkus poteka v treh delih:

1. **Izdelava izdelka**
2. **Predstavitev procesa in rezultatov,**
3. **Zagovor pred komisijo.**

1. Izdelava izdelka (digitalni + fizični del)

- Analiza naloge in razumevanje delovanja avtomatiziranega procesa (kaj mora sistem početi, kateri vhodi in izhodi so uporabljeni).
- Zasnova krmilne logike in poteka delovanja (npr. zaporedje korakov, pogoji, varnostne blokade).
- Izdelava PLK-programa v ustreznem jeziku (LAD ali FBD) v razvojnem okolju ali simulatorju.
- Nastavitev in konfiguracija vhodov in izhodov (senzorji, tipke, aktuatorji, signalne luči).
- Povezava programa s fizično ali simulirano opremo (PLK, simulator).
- Preizkus delovanja sistema in odpravljanje morebitnih napak.
- Priprava osnovne tehnične dokumentacije (opis delovanja, seznam vhodov in izhodov, komentarji v programu).

2. Predstavitev procesa in rezultatov

- Kandidat pripravi **kratko predstavitev (5–7 minut)**, kjer prikaže:
  - Namen in delovanje izdelane avtomatizirane rešitve.
  - Osnovno zasnovo krmilnega procesa in uporabljena logika.
  - Strukturo PLK-programa (glavne funkcije, vhodi in izhodi).
  - Rezultate testiranja in morebitne odpravljene napake.
  - Kratko oceno delovanja in možne izboljšave.

3. Zagovor

- Komisija dijaku postavi **vprašanja o postopku**, izbranih rešitvah in možnih izboljšavah.
- Kandidat odgovarja na vprašanja, pri katerih pojasni razumevanje osnovnih principov delovanja PLK, zasnove krmilne logike, povezave med programom in avtomatiziranim procesom ter uporabljenih tehničnih rešitev.

Kriteriji ocenjevanja:

- **Funkcionalnost rešitve** – ali avtomatizirani sistem deluje skladno z zahtevami naloge. (0–2 točki)
- **Pravilnost in kakovost PLK-programa** – logična zasnova, pravilna uporaba programskih elementov (LAD/FBD, časovniki, logika). (0–2 točki)
- **Uporaba vhodov in izhodov** – ustrezna povezava senzorjev, tipk in aktuatorjev z delovanjem sistema. (0–2 točki)

- **Testiranje in diagnostika** – sposobnost zaznavanja, razlage in odprave napak. (0–2 točki)
- **Uporaba tehnične dokumentacije in preglednost rešitve** – jasnost strukture, osnovna dokumentacija, komentiranje programa. (0–2 točki)
- **Samostojnost in strokovni pristop** – način dela, upoštevanje postopkov, varnosti in tehničnih pravil. (0–2 točki)
- **Predstavitev in zagovor** – jasnost razlage, razumevanje rešitev in odgovarjanje na vprašanja komisije. (0–2 točki)

Oblikovanje ocene:

- 0–6 točk: nezadostno
- 7–10 točk: dobro
- 11–14 točk: odlično

Za pridobitev mikrodokazila: min. 7 točk (min. dobro), nobeden od kriterijev ne sme biti ocenjen z 0 točkami.

Dostop do Open Badge – …….

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Povezava preko spletne strani: https://www.cl-bvet.eu/education-and-training/

Za pridobitev Open Badge -……. je potrebno uspešno zaključiti usposabljanje. Oddati je potrebno projektno nalogo in kratko prezentacijo …….. Projektna naloga in prezentacija morata biti uspešno ocenjena.

Izbira naloge:

- Izberite ……
- Izdelek …….
- Uporaba že obstoječih rešitev ni dovoljena.
- Oddajte na spodnji povezavi.

Predstavitev:

- Pripravite kratko predstavitev (2-3 strani) …….
- Predstavitev oddajte na spodnji povezavi.

Rok oddaje:

- **Digitalne datoteke in predstavitve naložite na spodnji povezavi najkasneje do ……..**

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7. **Način zagotavljanja kakovosti**

Zagotavljaje kakovosti se izvede skladno s Pravilnik o sistemu zagotavljanja kakovosti za kratke programe z mikrodokazili …….

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Short training program Microcredentials (Open Badge)

PLC Fundamentals for Smart Manufacturing

The training program was prepared by

Šolski center Novo mesto,
Srednja elektro-računalniška šola in tehniška gimnazija

Experts:

Marko Simčič

Educational program providers

Project: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Project partners: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna skola Velika Gorica (Croatia), Tehnicka skola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja strucna skola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro)

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Basic information about the training program

Naziv programa usposabljanja:

PLC Fundamentals for Smart Manufacturing

Name of training program:

50 hours

Credit points:

2 KT

Educational areas:

Electrical engineering, mechatronics

Pridobljena potrdila in značke:

A participant who successfully completes the training program receives an official certificate of completion and a digital Open Badge, which confirms the acquired competencies in the field of programming basics and the use of programmable logic controllers (PLC). The Open Badge contains verifiable data on: • the badge holder, • the training provider, • the content and scope of the training (50 hours, 2 ECTS), • the acquired competencies, • the method of knowledge assessment (practical test and defense). The badge proves that the holder is able to: • develop and test a simple PLC program, • connect PLCs to input-output devices, • use basic testing and diagnostic tools, • understand and use technical documentation, • participate in solving technical tasks in an automated environment. The Open Badge is issued in digital form and is transferable and verifiable on international platforms (e.g. Open Badge Factory), so the participant can use it in their CV, on LinkedIn or when demonstrating competence to employers and educational institutions. The certificate and badge together represent official and trustworthy evidence of successfully acquired professional competences in the field of industrial automation and PLC.

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1. Description and target group of the training program:

Program description

The Programmable Logic Controller (PLC) Programming Fundamentals program is a short, practically oriented training course designed to provide basic knowledge in the field of industrial automation. Participants learn about the role and structure of PLCs and are trained in basic programming using standard programming languages (LAD, FBD). The program emphasizes practical work, solving simple industrial cases, and testing and basic diagnostics of PLC programs.

Target group

The training program is intended for students and adult participants who are studying or working in the field of electrical engineering, mechatronics, mechanical engineering or related technical fields. It is suitable for beginners in the field of industrial automation who want to acquire basic knowledge of programming programmable logic controllers (PLC), and for employees in the industry who need a fundamental understanding of the operation and programming of PLCs to perform their work tasks. The program is also suitable for anyone who wants to further train or upgrade their competencies for work in automated and digitalized production environments.

2. Competencies

Through training, the participant develops the following professional competencies:

Competencies acquired after the training program (3-5)
1. Basic PLC programming **2. Using PLCs in automated systems** **3. Testing and basic diagnostics of PLC programs** **4. Reading and using technical documentation** **5. Solving technical problems in a team**

3. Learning objectives

Competencies: **Basic PLC programming**

Participant

• Explain the role of programmable logic controllers (PLC) in automated processes and the basic principles of PLC control. • Define the basic components of a PLC system (hardware, inputs/outputs, programming environment) and their function in the control system.

- Select the appropriate basic programming language and programming elements (e.g. LAD, FBD, logic functions, timers) based on the requirements of a simple control task.
- Create a simple PLC program to control a basic automated process and test the program in a simulation or real environment.
- Observe the basic rules of structured programming, security, code readability, and basic technical and industrial standards.

Competencies: **Use of PLC in automated systems**

Participant

- Produces basic control solution using PLC for simple automated process based on given functional requirements.
- Adapts the PLC program and system settings according to changes in the process, used sensors or actuators.
- Converts a logical description or scheme of an automated process (e.g. functional description, operation sequence) into a working PLC program.
- Sets input-output parameters, communication settings and basic system parameters for the correct operation of the PLC in an automated system.

Competencies: **Testing and basic diagnostics of PLC programs**

Participant

- Prepares and sets up a test environment to verify the operation of the PLC program, including the use of simulation tools and basic diagnostic functions of the development environment.
- Analyzes the operation of the PLC program and the system's responses to input signals and identifies simple logical, functional or connection errors.
- Performs testing, verification and troubleshooting procedures for basic errors in the PLC program and confirms the correct operation of the control process.
- Maintains reliable operation of the PLC program by making basic adjustments, updates and documenting changes made.

Competencies: **Reading and using technical documentation**

Participant

- Understands the structure and content of technical documentation for PLCs.
- Interprets electrical and functional diagrams.
- Uses documentation for PLC configuration and programming.
- Checks compliance of implementation with documentation.
- Observes applicable standards and safety requirements.

Competencies: **Solving technical problems in the team**

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Participant

- Participates in solving technical tasks in the team.
- Communicates technical solutions and problems with other team members.
- Contributes to the joint plan and implementation of the PLK-solution.
- Accepts feedback and uses it for improvement.
- Follows agreed procedures and safety rules.

4. Structure of the training program

Serial number	MODULE NAME	NUMBER OF ECTS POINTS	HOURS (h)		
			T	PP	TOTAL
1.	Module 1: PLC and Programming Basics	1	7	18	25
2.	Module 2: Use and diagnostics of PLCs in automated systems	1	7	18	25
		TOTAL	**14**	**36**	**50**

Module 1: PLC and programming basics

Objectives:

Participants gain a fundamental understanding of the role and operation of programmable logic controllers in automated systems. They acquire basic knowledge of PLC architecture and are trained to create simple PLC programs using basic programming languages (LAD, FBD). They develop the ability to think logically and understand basic control algorithms.

Contents:

- The role of PLC in automation.
- PLC architecture (hardware, I/O)
- Basic programming languages (LAD, FBD)
- Simple control algorithms.

Methods: Explanation with practical examples, video demonstrations of basic PLC concepts and programming, guided exercises on the computer (PLC simulation), solving short structured tasks, independent work using learning materials.

Module 2: Use and diagnostics of PLCs in automated systems

Objectives:

Participants acquire practical skills for using PLCs in simple automated processes. They are trained to connect PLCs to sensors and actuators, test program functionality, and perform basic diagnostics and troubleshooting. They develop the ability to use technical documentation and participate in solving practical industrial cases.

Contents:

- Connecting PLCs to sensors, switches, buttons, actuators
- Testing and basic diagnostics
- Using documentation
- Solving practical problems

Methods: practical work with a PLC simulator or physical equipment, problem and project tasks from industrial practice, work in small groups (team problem solving), demonstrations of testing and diagnostics of PLC programs, reflection and analysis of implemented solutions with feedback.

5. Method of implementation

The training is conducted in a combined workshop and online classroom:

- **Day 1** live 4 **hours**
- **Day 2** live 4 **hours**
- **Day 3** live 4 **hours**
- **Day 4** live 4 **hours**
- **Day 5** live 4 **hours**
- **Day 6** live 4 **hours**
- **Day 7** live 4 **hours**
- **Day 8** live 4 **hours**
- **Day 9** live 4 **hours**
- **Day 10** live 4 **hours**
- **Work in the online classroom** (videos, problem tasks, forum, creation and submission of an independent project) **– 6 hours**
- **Day 5 live in the workshop** - presentation of independent projects and assessment - **4 hours.**

Teaching methods: explanation, discussion, problem-based learning, practical exercises, project assignment.

6. Knowledge assessment

Knowledge assessment is carried out through a practical test and defense.
The practical test verifies all program competencies:

- **Project task**

The participant is given a real or simulated industrial task, e.g.:

- conveyor belt control,
- automatic doors,
- filling line,
- traffic lights with buttons and timers.

In doing so, he must:

- design the logic,
- write the PLC program,
- connect the inputs and outputs,
- test the system and correct errors.

This directly verifies: programming, PLC usage, diagnostics and process understanding.

This is the strongest proof *of competence for Open Badge and micro-evidence.*

- **Observation during practical work**

The mentor or committee monitors the participant during their work:

- whether they can independently resolve errors,
- whether they understand what they are doing,
- whether they can use the development environment.

It's not just the final product, but ***the process of work****.*

- **Short technical defense**
  After the project, the participant explains:
  - why he chose this logic,
  - how his program works,
  - what he would improve.

The committee asks him questions like:
- What happens if the sensor fails?
- Why did you use this timer?
- How would you adapt this for another process?

This tests understanding, not just mechanical application.

Mini quiz or knowledge test (optional support tool)

You can use a short online or written quiz to:

- basic concepts (I/O, LAD, FBD, timers),
- reading schemes,
- security.

This is not the main assessment, but:
a filter to see or understand the basics before going to the project.

- **Technical documentation as evidence**

The participant must submit:

- a description of the operation,
- a schematic or I/O list,
- a brief explanation of the program.

This shows:

- whether they can document the solution,
- whether they understand industry standards.

The practical test consists of three parts:

1. **Product development**
2. **Presentation of the process and results,**
3. **Defense before the committee.**

1. Product creation (digital + physical part)

- Analysis of the task and understanding of the operation of the automated process (what the system must do, which inputs and outputs are used).
- Design of the control logic and the flow of operation (e.g. sequence of steps, conditions, safety interlocks).
- Creation of a PLC program in the appropriate language (LAD or FBD) in a development environment or simulator.
- Setting and configuring inputs and outputs (sensors, buttons, actuators, signal lights).
- Connecting the program to physical or simulated equipment (PLC, simulator).
- Testing the operation of the system and eliminating any errors.
- Preparation of basic technical documentation (description of operation, list of inputs and outputs, comments in the program).

2. Presentation of the process and results

- The candidate prepares a short presentation (5–7 minutes) showing:
  - Purpose and operation of the developed automated solution.
  - Basic design of the control process and logic used.
  - Structure of the PLC program (main functions, inputs and outputs).
  - Test results and any errors fixed.
  - Brief evaluation of operation and possible improvements.

3. Defense

- The committee asks the student **questions about the procedure**, the chosen solutions and possible improvements.
- The candidate answers questions in which he explains his understanding of the basic principles of PLC operation, the design of control logic, the connection between the program and the automated process, and the technical solutions used.

Evaluation criteria:

- **Solution functionality –** does the automated system work in accordance with the requirements of the task. (0–2 points)
- **Correctness and quality of the PLC program –** logical design, correct use of program elements (LAD/FBD, timers, logic). (0–2 points)

- **Use of inputs and outputs –** appropriate connection of sensors, buttons and actuators with the operation of the system. (0–2 points)
- **Testing and diagnostics –** ability to detect, explain and eliminate errors. (0–2 points)
- **Use of technical documentation and transparency of the solution –** clarity of structure, basic documentation, program commenting. (0–2 points)
- **Independence and professional approach –** method of work, compliance with procedures, safety and technical rules. (0–2 points)
- **Presentation and defense –** clarity of explanation, understanding of solutions and answering the questions of the committee. (0–2 points)

Forming an assessment:

- 0–6 points: insufficient
- 7–10 points: good
- 11–14 points: great

To obtain micro-evidence: min. 7 points (min. good), none of the criteria may be rated with 0 points.

Access to Open Badge – ……..

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Link via website: https://www.cl-bvet.eu/education-and-training/

To obtain the Open Badge -……., it is necessary to successfully complete the training. It is necessary to submit a project assignment and a short presentation …….. The project assignment and presentation must be successfully assessed.

Task selection:

- • Select ……
- • Product ……..
- • The use of already existing solutions is not allowed.
- • Submit at the link below.

Presentation:

- Prepare a short presentation (2-3 pages) …….
- Submit your presentation at the link below.

Submission deadline:

- **Please upload digital files and presentations at the link below no later than ……..**

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

7. Quality assurance method

Quality assurance is carried out in accordance with the Rules on the Quality Assurance System for Short Micro-Evidence Programmes …….

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A short training program with microcredits

Creating simple automated systems using Arduino microcontrollers

The training program was prepared by:

JU Secondary Vocational School Pljevlja, Vuka Karadžića Street No. 37, Pljevlja, Montenegro

Expert team:

Velibor Pupović, professor of Serbian language and literature, Bojan Strunjaš, MA, professor of Serbian language and literature, Vladica Avramović, MA, B.Eng., Vida Milić, professor of English language, Jelena Drobnjak, professor of Serbian language and literature, Radan Kartal, pedagogue and Tanja Terzić, economist.

Initiators of the educational program

Project: ***CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments***

Project partners: School Center Novo Mesto, Euroskill d.o.o. (Slovenia), Vocational High School Velika Gorica (Croatia), Technical School Gradiška, Adult Education Center Banja Luka (Bosnia and Herzegovina), Vocational High School Pljevlja, Innovation and Entrepreneurship Center Tehnopolis (Montenegro).

Basic information about the Program

Program name:

Creating simple automated systems using Arduino microcontrollers

Program duration:

50 sati

Evaluation:

2 KT (ECTS)

Educational areas:

The program "Creation of simple automated systems using Arduino microcontroller" belongs to the following educational areas - technical areas:

- Electrical engineering and electronics;
- Automation and process control;
- Microcontroller systems and embedded systems;
- Programming and development of software solutions for system automation;
- Digital technologies and Internet of Things (IoT);
- Smart homes, smart cities and intelligent technical systems;
- Technical documentation and system diagnostics.

Certificates and badges received:

Upon successful completion of the program "Creating Simple Automated Systems Using Arduino Microcontrollers", participants receive a certificate of completion of training, which confirms the acquisition of knowledge and skills in the field of Arduino programming, controlling input-output devices and creating simple automated systems.

In addition to the certificate, participants are also awarded an Open Badge as a digital confirmation of the acquired competencies. The Open Badge enables verification of knowledge and skills in digital form and their sharing on professional networks, employment platforms and learning management systems.

The certificate and the Open Badge together confirm the participants' competence in designing, programming, testing and implementing simple automated systems based on Arduino microcontrollers, including their application in smart home, smart city and smart industry systems.

Description and target group of the training program:

Program description:

The program "Creating simple automated systems using Arduino microcontrollers" is intended to acquire basic knowledge and practical skills for designing, programming and implementing simple automated systems using the Arduino platform.

During the program, participants are introduced to the hardware and software structure of Arduino microcontrollers, connecting sensors, actuators and other input-output devices, and creating programs for controlling automated processes. Special emphasis is placed on practical work, testing and diagnostics of the system, as well as on the application of acquired knowledge in designing smart home subsystems (lighting control, home appliance control, temperature measurement, fire protection, etc.), as well as designing simple industrial systems in production (IoT systems for remote control of production processes).

The program contributes to the development of digital and technical competencies necessary for working with modern automation technologies and represents a good basis for further training in the fields of microcontrollers, industrial automation, robotics and the Internet of Things (IoT).

Target group:

The program "Creating simple automated systems using Arduino microcontrollers" is intended for unemployed and employed individuals who want to acquire or improve knowledge and skills in the field of microcontroller systems, programming and automation.

The program is especially intended for students, technicians, teachers of professional subjects, employees in production and technical activities, as well as all interested persons who want to develop competencies in the design and implementation of simple automated systems.

The program is suitable for participants who want to acquire practical knowledge in the field of Arduino platform, sensors, actuators, smart home systems and the basics of industrial automation, regardless of previous experience in programming.

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Skills (competences)

Upon completion of the program, the participant will be able to:

1. **Understands the basic role of the Arduino microcontroller in automated systems and explains its application in practice.**
2. **Recognizes and analyzes the hardware and software structure of the Arduino platform.**
3. **Connects sensors, actuators and relays to the Arduino microcontroller via input-output pins.**
4. **Programs the Arduino microcontroller to implement simple automated solutions.**
5. **Tests and diagnoses basic errors in the hardware and software parts of the system.**
6. **Analyzes and applies the basic principles of operation of automated systems in production and smart home systems in simple technical solutions.**

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Learning objectives

Competency 1:

Understands the basic role of the Arduino microcontroller in automated systems and explains its application in practice.

Learning objectives:

- Explain the basic purpose, types and role of Arduino microcontrollers in automation.
- Recognize examples of Arduino system applications in real environments.
- Distinguish between the basic components of the Arduino ecosystem.

Competency 2:

Recognizes and analyzes the hardware and software structure of the Arduino platform.

Learning objectives:

- Identifies the basic hardware components of the Arduino board.
- Explains the role of the software environment (Arduino IDE).
- Connects the hardware and software elements of the system.

Competency 3:

It connects sensors, actuators, and relays to the Arduino microcontroller via input/output pins.

Learning objectives:

- Recognize basic sensors and actuators used in Arduino systems.
- Correctly connect input and output devices to Arduino pins.
- Explain the function of relays in smart home and lighting control systems.

Competency 4:

Programs the Arduino microcontroller to implement simple automated solutions.

Learning objectives:

- Write basic Arduino programs to control devices.
- Uses basic programming structures (loops, conditions, variables).
- Tests and corrects simple programming errors.

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Competency 5:

Testira i dijagnostikuje osnovne greške u hardverskom i softverskom dijelu sistema.

Learning objectives:

- Recognizes typical errors in connecting components.
- Uses basic methods of testing system functionality.
- Troubleshoots simple hardware and software errors in the designed system.

Competency 6:

Analyzes and applies the basic principles of automated systems in production and smart home systems in simple technical solutions.

Learning objectives:

- Explain the principles of operation of simple automated systems.
- Recognize the basic elements of a smart home system.
- Apply Arduino solutions in simple automated scenarios.

Structure of the training program

Serial number:	MODULE NAME:	Number of credits (ECTS):	Number of working hours (h):		
			Theory:	Practice:	TOTAL:
1.	Basics of hardware and software design with the Arduino microcontroller.	1	7	18	25
2.	Design and production of automated elements of smart home systems, smart cities and industrial systems.	1	7	18	25

TOTAL:	**2**	**14**	**36**	**50**

MODULE 1: BASICS OF HARDWARE AND SOFTWARE DESIGN WITH THE ARDUINO MICROCONTROLLER

Goal:

To enable participants to understand the basic structure of the Arduino microcontroller system, as well as to apply the basic principles of hardware connectivity and software programming in simple automated solutions.

Contents:

- Introduction to the Arduino platform and basic system components
- Microcontroller structure (input-output pins, power supply, communication)
- Basics of working in the Arduino IDE environment
- Basic programming elements (variables, conditions, loops)
- Connecting basic electronic components (LEDs, buttons, resistors)
- Safety and proper handling of electronic components
- Basic principles of testing and simulating the operation of the Arduino system

Methods:

Teaching is carried out through interactive lectures, demonstrations of the Arduino platform, practical laboratory exercises, guided workshops, simulations of basic electronic circuits, and individual work of the participants. Special emphasis is placed on learning through practice, where participants independently connect components and create simple programming tasks in the Arduino IDE environment.

MODULE 2: DESIGN AND MANUFACTURING OF AUTOMATED ELEMENTS OF SMART HOME SYSTEMS, SMART CITIES AND SYSTEMS IN INDUSTRY

Goal:

Osposobiti polaznike za projektovanje i realizaciju jednostavnih automatizovanih rješenja baziranih na Arduino mikrokontroleru, sa primjenom u sistemima pametnih kuća, pametnih gradova i osnovnim industrijskim automatizovanim procesima.

Contents:

- Analysis of requirements for simple automated systems
- Application of sensors and actuators in smart home systems
- Basic elements of smart cities (lighting, monitoring, energy management)
- Design of simple industrial automated solutions

• Integration of hardware components with Arduino microcontroller
• Testing and optimization of system operation
• Documentation of developed solutions

Methods:

Teaching is realized through project work, practical laboratory exercises, work in groups and individually, demonstrations of examples from practice, simulations and problem solving. Participants create simple functional models of smart home systems and industrial processes, with constant mentoring support and practical testing of the created solutions.

Method of implementation

Training/teaching is carried out in the classroom, in the laboratory on equipment and online:

The program is implemented using a combined learning method (blended learning) for a total duration of 50 hours.

Structure of implementation:

Day 1 – live teaching in the computer classroom (7 hours)
2nd day – live teaching in the computer classroom (7 hours)
Day 3 – live teaching in the computer classroom (7 hours)
4th day – live teaching in the computer classroom (7 hours)

Online learning (2 working days - 18 hours):

• video recording and simulation of solutions
• group presentation of problem tasks
• presentation of developed solutions
• forum for discussion and consultation
• development and submission of an independent project

Day 5 – live classes in the workshop (4 hours):

• presentation of independent projects
• evaluation and analysis of developed solutions

TOTAL: 50 hours

This implementation model allows for a combination of theoretical teaching, practical work, and independent learning through digital tools, with a focus on developing practical competencies in the field of Arduino systems and automation.

Training methods:

In the implementation of the program, combined teaching methods are applied, which enable active learning, development of practical skills and application of knowledge in real situations.

Training methods include:

- research approach to learning
- problem-solving (problem-based learning)
- interactive lectures with multimedia presentations
- workshops and guided practical work
- practical work with Arduino controllers and input-output devices
- practical work in an appropriate software environment (Arduino IDE and simulations)
- solving real problems from practice (smart homes, smart cities, smart agriculture)
- individual mentoring and continuous feedback
- project work and presentation of solutions
- electronic questionnaire for testing theoretical knowledge
- evaluation of group and individual work of participants for the purpose of testing practical knowledge and skills for obtaining the Open Badge.

Knowledge and skills assessment

Assessment of knowledge and skills is carried out through a combination of theoretical testing, practical tasks and defense of the project solution.

The knowledge test includes:

• theoretical knowledge of the basics of Arduino microcontrollers and their components
• understanding of the hardware and software structure of the system
• practical connection of sensors, actuators and relays with the Arduino platform
• creation and testing of simple Arduino programs
• solving assigned problems in the field of smart homes and automation
• diagnostics and elimination of basic errors in the operation of the system
• creation and presentation of an independent project solution

Forms of assessment:

• electronic or paper test (theoretical knowledge)
• practical tasks on the Arduino platform
• evaluation of project work and group activities
• defense and presentation of the developed solution

The final grade is based on the overall success of the theoretical part, practical work and the quality of the completed project assignment.

The practical exam takes place in three parts:

1. **Creation of a project task (Arduino-based automated system), which includes:**

   • analysis of the given problem scenario (smart house, smart city or similar system);
   • selection and connection of sensors, actuators and Arduino microcontrollers;
   • creation and implementation of Arduino programs;
   • testing the functionality of the system in simulation or on real equipment;
   • basic technical documentation of the solution.

2. **Presentation of the development process and results of the project task, with explanation:**

   • selected technical solution;
   • methods of connecting hardware and software;
   • operating principles of the created system;
   • presentation of work results (demonstration or video).

3. **Answering the Commission's questions to check understanding:**

   • Arduino architecture and basic system components;
   • principles of programming and controlling input-output devices;
   • methods of diagnostics and troubleshooting;
   • applications of systems in smart homes and automation.

Evaluation criteria:

The assessment of the knowledge and skills of the participants is carried out according to the following criteria. Each criterion is scored in the range from 0 to 2 points, with the maximum number of points being 14.

Evaluation criteria:

- Understanding and analysis of the given problem scenario (smart home / smart system)
- Quality of selection and connection of hardware components (sensors, actuators, Arduino)
- Correctness and functionality of Arduino software solution
- Quality of system implementation and testing (simulation or real equipment)
- Ability to diagnose and fix errors in the system

- Quality and orderliness of technical documentation
- Quality of presentation, communication and answers to questions from the Commission

Rating scale:

0 – criterion not met

1 – criterion partially met

2 – criterion fully met

REQUIREMENTS FOR COMPLETION OF THE PROGRAM AND SUCCESS

The participant successfully completes the program if he obtains at least 8 points out of a total of 14 possible points in the practical exam.

Based on the total number of points achieved, success is determined as follows:

- 0–7 points – failed
- 8–11 points – passed
- 12–14 points – passed with high success

Upon completion of the Program, the participant obtains a certificate of competence for the creation of simple automated systems using the Arduino microcontroller, including hardware connection, programming, testing and creation of technical documentation.

PROCEDURE FOR OBTAINING AN OPEN BADGE

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Project: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Website link: https://www.cl-bvet.eu/education-and-training/

To obtain the Open Badge, the participant must successfully complete the training program and meet the following requirements:

- successful attendance and completion of the entire training program
- creation of a functional project task based on the Arduino microcontroller
- connection and application of sensors, actuators and input-output devices in the system
- creation and implementation of the Arduino program solution
- testing and demonstration of the work of the created system (simulation or real equipment)
- preparation of a short presentation (7–10 slides) of the created solution
- positive assessment of the project assignment and presentation by the committee

The Open Badge is awarded to participants who have proven their acquired competencies in the field of microcontroller systems, Arduino platform programming, basic automation, and the application of smart solution systems through practical work and evaluation.

Task selection:

1. The participant chooses or receives a given problem task, in the field of creating simple automated systems using Arduino microcontrollers.
2. The task includes the design and implementation of a functional solution, which uses sensors, actuators and the Arduino programming platform.
3. The use of existing or previously created solutions is not allowed.
4. The project must be independently developed, tested and documented.
5. The completed project task and accompanying documentation are submitted via the link provided below.

Presentation:

1. A short presentation (7–10 slides) is prepared that shows the problem, the components used, the Arduino programming solution and how the system works.
2. The presentation should contain a display of the system's operation (photos, recording or video).

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3. The presentation is delivered via the link below.

Application and submission deadline:

• All digital materials (project assignment and presentation) must be submitted no later than _____.

Link for registration and submission of materials:

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

The Open Badge is awarded to participants who successfully complete all of the above steps and whose project assignment and presentation are positively evaluated.

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Quality assurance method

Quality assurance is carried out in accordance with the Regulation on the Quality Assurance System for Short Training Programs with Microcredit (Open Badge).

Kratki program obuke sa mikrokreditima

Izrada jednostavnih automatizovanih sistema, upotrebom mikrokontrolera Arduino

Program treninga pripremili su:

JU Srednja stručna škola Pljevlja, ulica Vuka Karadžića broj 37. Pljevlja, Crna Gora

Stručni tim:

Velibor Pupović, profesor srpskog jezika i književnosti, Mr Bojan Strunjaš, profesor srpskog jezika i književnosti, Mr Vladica Avramović, dipl.ing.el, Vida Milić, profesor engleskog jezika, Jelena Drobnjak, profesor srpskog jezika i književnosti, Radan Kartal, pedagog i Tanja Terzić, ekonomista.

Inicijatori obrazovnog programa

Projekat: ***CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments***

Partneri na projektu: Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna škola Velika Gorica (Croatia), Tehnička škola Gradiška, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja stručna škola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro).

Osnovne informacije o programu

Naziv programa:

Izrada jednostavnih automatizovanih sistema, upotrebom mikrokontrolera Arduino

Trajanje programa:

50 sati

Vrednovanje:

2 KT (ECTS)

Obrazovna područja:

Program „Izrada jednostavnih automatizovanih sistema upotrebom mikrokontrolera Arduino“ pripada sljedećim obrazovnim područjima – tehničkim oblastima:

- Elektrotehnika i elektronika;
- Automatizacija i upravljanje procesima;
- Mikrokontrolerski sistemi i ugrađeni sistemi (Embedded Systems);
- Programiranje i razvoj softverskih rješenja za automatizaciju sistema;
- Digitalne tehnologije i Internet stvari (IoT);
- Pametne kuće, pametni gradovi i inteligentni tehnički sistemi;
- Tehnička dokumentacija i dijagnostika sistema.

Dobijeni sertifikati i bedževi:

Po uspješnom završetku programa „Izrada jednostavnih automatizovanih sistema upotrebom mikrokontrolera Arduino“ polaznici dobijaju sertifikat o završenoj obuci, kojim se potvrđuje sticanje znanja i vještina iz oblasti Arduino programiranja, upravljanja ulazno-izlaznim uređajima i izrade jednostavnih automatizovanih sistema.

Pored sertifikata, polaznicima se dodjeljuje i Open Badge (otvoreni bedž) kao digitalna potvrda stečenih kompetencija. Open Badge omogućava verifikaciju znanja i vještina u digitalnom obliku te njihovo dijeljenje na profesionalnim mrežama, platformama za zapošljavanje i sistemima za upravljanje učenjem.

Sertifikat i Open Badge zajedno potvrđuju osposobljenost polaznika za projektovanje, programiranje, testiranje i implementaciju jednostavnih automatizovanih sistema, zasnovanih na Arduino mikrokontrolerima, uključujući njihovu primjenu u sistemima pametnih kuća, pametnih gradova i pametne industrije.

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Opis i ciljna grupa programa osposobljavanja:

Opis programa:

Program „Izrada jednostavnih automatizovanih sistema upotrebom mikrokontrolera Arduino“ namijenjen je sticanju osnovnih znanja i praktičnih vještina za projektovanje, programiranje i implementaciju jednostavnih automatizovanih sistema, korištenjem Arduino platforme.

Tokom programa polaznici se upoznaju sa hardverskom i softverskom strukturom Arduino mikrokontrolera, povezivanjem senzora, aktuatora i drugih ulazno-izlaznih uređaja, te izradom programa za upravljanje automatizovanim procesima. Poseban naglasak stavlja se na praktičan rad, testiranje i dijagnostiku sistema, kao i na primjenu stečenih znanja u projektovanju podsistema pametnih kuća (upravljanje rasvjetom, upravljanje kućnim uređajima, mjerenje temperature, zaštita od požara i sl.), kao i projektovanje jednostavnih industrijskih sistema u proizvodnji (IoT sistemi za daljinsku kontrolu procesa proizvodnje).

Program doprinosi razvoju digitalnih i tehničkih kompetencija, potrebnih za rad sa savremenim tehnologijama automatizacije i predstavlja dobru osnovu za dalje usavršavanje u oblastima mikrokontrolera, industrijske automatizacije, robotike i Internet stvari (IoT).

Ciljna grupa:

Program „Izrada jednostavnih automatizovanih sistema upotrebom mikrokontrolera Arduino“ namijenjen je nezaposlenim i zaposlenim licima, koja žele da steknu ili unaprijede znanja i vještine iz oblasti mikrokontrolerskih sistema, programiranja i automatizacije.

Program je posebno namijenjen učenicima, studentima, tehničarima, nastavnicima stručnih predmeta, zaposlenima u proizvodnim i tehničkim djelatnostima, kao i svim zainteresovanim licima koja žele da razviju kompetencije za projektovanje i realizaciju jednostavnih automatizovanih sistema.

Program je pogodan za polaznike koji žele da steknu praktična znanja iz oblasti Arduino platforme, senzora, aktuatora, sistema pametnih kuća i osnova industrijske automatizacije, bez obzira na prethodno iskustvo u programiranju.

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Vještine (kompetencije)

Po završetku programa polaznik će biti osposobljen da:

1. **Razumije osnovnu ulogu Arduino mikrokontrolera u automatizovanim sistemima i objašnjava njegovu primjenu u praksi.**
2. **Prepoznaje i analizira hardversku i softversku strukturu Arduino platforme.**
3. **Povezuje senzore, aktuatore i releje sa Arduino mikrokontrolerom putem ulazno-izlaznih pinova.**
4. **Programira Arduino mikrokontroler za realizaciju jednostavnih automatizovanih rješenja.**
5. **Testira i dijagnostikuje osnovne greške u hardverskom i softverskom dijelu sistema.**
6. **Analizira i primjenjuje osnovne principe rada automatizovanih sistema u proizvodnji i sistema pametnih kuća u jednostavnim tehničkim rješenjima.**

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Ciljevi učenja

Kompetencija 1:

Razumije osnovnu ulogu Arduino mikrokontrolera u automatizovanim sistemima i objašnjava njegovu primjenu u praksi.

Ciljevi učenja:

- Objasniti osnovnu namjenu, vrste i ulogu Arduino mikrokontrolera u automatizaciji.
- Prepozna primjere primjene Arduino sistema u realnim okruženjima.
- Razlikuje osnovne komponente Arduino ekosistema.

Kompetencija 2:

Prepoznaje i analizira hardversku i softversku strukturu Arduino platforme.

Ciljevi učenja:

- Identifikuje osnovne hardverske komponente Arduino ploče.
- Objasniti ulogu softverskog okruženja (Arduino IDE).
- Povezuje hardverske i softverske elemente sistema.

Kompetencija 3:

Povezuje senzore, aktuatore i releje, sa Arduino mikrokontrolerom putem ulazno-izlaznih pinova.

Ciljevi učenja:

- Prepoznaje osnovne senzore i aktuatore, koji se koriste u Arduino sistemima.
- Pravilno povezuje ulazne i izlazne uređaje na Arduino pinove.
- Objasni funkciju releja u upravljačkim sistemima pametnih kuća i upravljanja raasvjetom.

Kompetencija 4:

Programira Arduino mikrokontroler za realizaciju jednostavnih automatizovanih rješenja.

Ciljevi učenja:

- Napiše osnovne Arduino programe, za upravljanje uređajima.
- Koristi osnovne programske strukture (petlje, uslovi, varijable).
- Testirata i ispravlja jednostavne programske greške.

Kompetencija 5:

Testira i dijagnostikuje osnovne greške u hardverskom i softverskom dijelu sistema.

Ciljevi učenja:

- Prepoznaje tipične greške u povezivanju komponenti.
- Koristi osnovne metode testiranja funkcionalnosti sistema.
- Otkloni jednostavne hardverske i softverske greške u projekovanom sistemu.

Kompetencija 6:

Analizira i primjenjuje osnovne principe rada automatizovanih sistema u proizvodnji i sistema pametnih kuća u jednostavnim tehničkim rješenjima.

Ciljevi učenja:

- Objasni principe rada jednostavnih automatizovanih sistema.
- Prepozna osnovne elemente sistema pametne kuće.
- Primijeniti Arduino rješenja u jednostavnim automatizovanim scenarijima.

Struktura programa osposobljavanja

Redni broj:	IME MODULA:	Broj kredita (ECTS):	Broj časova rada (h):		
			Teorija:	Praksa:	UKUPNO:
1.	**Osnove hardverskog i softverskog projektovanja sa mikrokontrolerom Arduino.**	1	7	18	25
2.	**Projektovanje i izrada automatizovanih elemenata sistema pametnih kuća, pametnih gradova i sistema u industriji.**	1	7	18	25

UKUPNO:	**2**	**14**	**36**	**50**

MODUL 1: OSNOVE HARDVERSKOG I SOFTVERSKOG PROJEKTOVANJA SA MIKROKONTROLEROM ARDUINO

Cilj:

Osposobiti polaznike za razumijevanje osnovne strukture Arduino mikrokontrolerskog sistema, kao i za primjenu osnovnih principa hardverskog povezivanja i softverskog programiranja u jednostavnim automatizovanim rješenjima.

Sadržaj:

- Uvod u Arduino platformu i osnovne komponente sistema
- Struktura mikrokontrolera (ulazno-izlazni pinovi, napajanje, komunikacija)
- Osnove rada u Arduino IDE okruženju
- Osnovni programski elementi (varijable, uslovi, petlje)
- Povezivanje osnovnih elektronskih komponenti (LED, tasteri, otpornici)
- Sigurnost i pravilno rukovanje elektronskim komponentama
- Osnovni principi testiranja i simulacije rada Arduino sistema

Metode:

Nastava se realizuje kroz interaktivna predavanja, demonstracije rada Arduino platforme, praktične laboratorijske vježbe, vođene radionice, simulacije osnovnih elektronskih kola i individualni rad polaznika. Poseban naglasak stavlja se na učenje kroz praksu, gdje polaznici samostalno povezuju komponente i izrađuju jednostavne programske zadatke u Arduino IDE okruženju.

MODUL 2: PROJEKTOVANJE I IZRADA AUTOMATIZOVANIH ELEMENATA SISTEMA PAMETNIH KUĆA, PAMETNIH GRADOVA I SISTEMA U INDUSTRIJI

Cilj:

Osposobiti polaznike za projektovanje i realizaciju jednostavnih automatizovanih rješenja baziranih na Arduino mikrokontroleru, sa primjenom u sistemima pametnih kuća, pametnih gradova i osnovnim industrijskim automatizovanim procesima.

Sadržaj:

- Analiza zahtjeva jednostavnih automatizovanih sistema
- Primjena senzora i aktuatora u sistemima pametne kuće
- Osnovni elementi pametnih gradova (rasvjeta, monitoring, upravljanje energijom)
- Projektovanje jednostavnih industrijskih automatizovanih rješenja

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- Integracija hardverskih komponenti sa Arduino mikrokontrolerom
- Testiranje i optimizacija rada sistema
- Dokumentovanje izrađenih rješenja

Metode:

Nastava se realizuje kroz projektni rad, praktične laboratorijske vježbe, rad u grupama i individualno, demonstracije primjera iz prakse, simulacije i rješavanje problemskih zadataka. Polaznici izrađuju jednostavne funkcionalne modele sistema pametnih kuća i industrijskih procesa, uz stalnu mentorsku podršku i praktično testiranje izrađenih rješenja.

Način realizacije

Obuka/nastava se realzuje u učionici, u laboratoriji na opremi i online:

Program se realizuje kombinovanim načinom učenja (blended learning) u ukupnom trajanju od 50 časova.

Struktura realizacije:

1. dan – nastava uživo u računarskoj učionici (7 časova)
2. dan – nastava uživo u računarskoj učionici (7 časova)
3. dan – nastava uživo u računarskoj učionici (7 časova)
4. dan – nastava uživo u računarskoj učionici (7 časova)

Online učenje (2 radna dana – 18 časova):

- izrada video zapisa i simulacija rješenja
- grupno prezentovanje problemskih zadataka
- prezentacija izrađenih rješenja
- forum za raspravu i konsultacije
- izrada i predaja samostalnog projekta

5. dan – nastava uživo u radionici (4 časa):

- prezentacija samostalnih projekata
- evaluacija i analiza izrađenih rješenja

UKUPNO: 50 časova

Ovakav model realizacije omogućava kombinaciju teorijske nastave, praktičnog rada i samostalnog učenja kroz digitalne alate, uz fokus na razvoj praktičnih kompetencija u oblasti Arduino sistema i automatizacije.

Metode obuke:

U realizaciji programa primjenjuju se kombinovane metode nastave, koje omogućavaju aktivno učenje, razvoj praktičnih vještina i primjenu znanja u realnim situacijama.

Metode obuke uključuju:

- istraživački pristup učenju
- rješavanje problema (problem-based learning)
- interaktivna predavanja uz multimedijalne prezentacije
- radionice i vođeni praktični rad
- praktičan rad s Arduino kontrolerima i ulazno-izlaznim uređajima
- praktičan rad u odgovarajućem softverskom okruženju (Arduino IDE i simulacije)
- rješavanje stvarnih problema iz prakse (pametne kuće, pametni gradovi, pametna poljoprivreda)
- individualno mentorstvo i kontinuirane povratne informacije
- projektni rad i prezentacija rješenja
- elektronski upitnik za provjeru teorijskih znanja
- evaluacija grupnog i individualnog rada polaznika u svrhu provjere praktičnih znanja i vještina za dobijanje Open Badge-a.

Procjena znanja i vještina

Procjena znanja i vještina realizuje se kroz kombinaciju teorijske provjere, praktičnih zadataka i odbrane projektnog rješenja.

Provjera znanja obuhvata:

- teorijsko znanje iz osnova Arduino mikrokontrolera i njegovih komponenti
- razumijevanje hardverske i softverske strukture sistema
- praktično povezivanje senzora, aktuatora i releja sa Arduino platformom
- izradu i testiranje jednostavnih Arduino programa
- rješavanje zadatih problemskih zadataka iz oblasti pametnih kuća i automatizacije
- dijagnostiku i otklanjanje osnovnih grešaka u radu sistema
- izradu i prezentaciju samostalnog projektnog rješenja

Oblici procjene:

- elektronski ili papirni test (teorijska znanja)
- praktični zadaci na Arduino platformi
- evaluacija projektnog rada i grupne aktivnosti
- odbrana i prezentacija izrađenog rješenja

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Završna ocjena zasniva se na ukupnom uspjehu iz teorijskog dijela, praktičnog rada i kvaliteta izrađenog projektnog zadatka.

Praktični ispit odvija se u tri dela:

1. **Izrada projektnog zadatka (Arduino baziran automatizovani sistem), koji obuhvata:**

    - analizu zadatog problemskog scenarija (pametna kuća, pametni grad ili sličan sistem);
    - izbor i povezivanje senzora, aktuatora i Arduino mikrokontrolera;
    - izradu i implementaciju Arduino programa;
    - testiranje funkcionalnosti sistema u simulaciji ili na realnoj opremi;
    - osnovnu tehničku dokumentaciju rješenja.

2. **Prezentacija procesa izrade i rezultata projektnog zadatka, uz obrazloženje:**

    - odabranog tehničkog rješenja;
    - načina povezivanja hardvera i softvera;
    - principa rada izrađenog sistema;
    - prikaza rezultata rada (demonstracija ili video).

3. **Odgovaranje na pitanja Komisije radi provjere razumijevanja:**

    - Arduino arhitekture i osnovnih komponenti sistema;
    - principa programiranja i upravljanja ulazno-izlaznim uređajima;
    - načina dijagnostike i otklanjanja grešaka;
    - primjene sistema u pametnim kućama i automatizaciji.

Kriterijumi ocjenjivanja:

Procjena znanja i vještina polaznika, vrši se po sljedećim kriterijumima. Svaki kriterijum se ocjenjuje u rasponu od 0 do 2 boda, pri čemu maksimalan broj bodova iznosi 14.

Kriterijumi ocjenjivanja:

- Razumijevanje i analiza zadatog problemskog scenarija (pametna kuća / pametni sistem)
- Kvalitet izbora i povezivanja hardverskih komponenti (senzori, aktuatori, Arduino)

- Ispravnost i funkcionalnost Arduino programskog rješenja
- Kvalitet implementacije i testiranja sistema (simulacija ili realna oprema)
- Sposobnost dijagnostike i otklanjanja grešaka u sistemu
- Kvalitet i urednost tehničke dokumentacije
- Kvalitet prezentacije, komunikacija i odgovori na pitanja Komisije

Skala ocjenjivanja:

0 – kriterijum nije ispunjen
1 – kriterijum je djelimično ispunjen
2 – kriterijum je u potpunosti ispunjen

USLOVI ZA ZAVRŠETAK PROGRAMA I USPEŠNOST

Polaznik uspješno završava program ukoliko na praktičnom ispitu ostvari najmanje 8 bodova od ukupno 14 mogućih bodova.

Na osnovu ukupnog broja ostvarenih bodova, uspjeh se utvrđuje na sljedeći način:

- 0–7 bodova – nije položio/la
- 8–11 bodova – položio/la
- 12–14 bodova – položio/la sa visokim uspjehom

Završetkom Programa, polaznik stiče potvrdu o osposobljenosti za izradu jednostavnih automatizovanih sistema upotrebom Arduino mikrokontrolera, uključujući povezivanje hardvera , programiranje, testiranje i izradu tehničke dokumentacije.

POSTUPAK ZA STICANJE OPEN BADGE (OTVORENOG BEDŽA)

Šolski center Novo mesto, Šegova ulica 112, 8000 Novo mesto

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Poveznica putem web stranice: https://www.cl-bvet.eu/education-and-training/

Za dobijanje Open Badge (Otvorenog bedža) potrebno je da polaznik uspješno završi program obuke i ispuni sljedeće uslove:

- uspješno pohađanje i završetak cjelokupnog programa obuke
- izrada funkcionalnog projektnog zadatka zasnovanog na Arduino mikrokontroleru
- povezivanje i primjena senzora, aktuatora i ulazno-izlaznih uređaja u sistemu
- izrada i implementacija Arduino programskog rješenja
- testiranje i demonstracija rada izrađenog sistema (simulacija ili realna oprema)
- priprema kratke prezentacije (7–10 slajdova) izrađenog rješenja
- pozitivna ocjena projektnog zadatka i prezentacije od strane komisije

Open Badge se dodjeljuje polaznicima, koji su dokazali stečene kompetencije u oblasti mikrokontrolerskih sistema, programiranja Arduino platforme, osnovne automatizacije i primjene sistema pametnih rješenja kroz praktičan rad i evaluaciju.

Izbor zadatka:

1. Polaznik bira ili dobija zadati problemski zadatak, iz oblasti izrade jednostavnih automatizovanih sistema korištenjem Arduino mikrokontrolera.
2. Zadatak uključuje projektovanje i realizaciju funkcionalnog rješenja, koje koristi senzore, aktuatorske elemente i Arduino platformu za programiranje.
3. Nije dopuštena upotreba već postojećih ili ranije izrađenih rješenja.
4. Projekat mora biti samostalno izrađen, testiran i dokumentovan.
5. Završeni projektni zadatak i prateća dokumentacija predaju se putem linka navedenog u nastavku.

Predstavljanje:

1. Priprema se kratka prezentacija (7–10 slajdova) koja prikazuje problem, korištene komponente, Arduino programsko rješenje i način rada sistema.
2. Prezentacija treba da sadrži prikaz rada sistema (fotografije, snimak ili video).
3. Prezentacija se dostavlja putem linka navedenog u nastavku.

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Rok za prijavu i predaju:

• Svi digitalni materijali (projektni zadatak i prezentacija) moraju biti dostavljeni najkasnije do _____.

Link za prijavu i predaju materijala:
https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

Open Badge se dodeljuje polaznicima koji uspešno završe sve navedene korake i čiji projektni zadatak i prezentacija budu pozitivno ocenjeni.

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Metoda osiguranja kvaliteta

Osiguranje kvaliteta provodi se u skladu s Pravilnikom o sistemu osiguranja kvaliteta kratkih programa obuka sa mikrokreditima (*Open Badge*).

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Kratki program obrazovanja Mikrokvalifikacije (Open Badge)

Realizacija projekata u 3D tehnologijama

Program obrazovanja pripremio je

Srednja strukovna škola Velika Gorica

Ivan Živković, Marin Širol

Stručnjaci:

Ivan Živković

Pružatelji obrazovnog programa

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Projektni partneri: Školski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna škola Velika Gorica (Croatia), Tehnicka škola Gradiska, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Srednja stručna skola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro)

PAGE * MERGEFORMAT

Osnovne informacije o programu obuke

Naziv programa osposobljavanja:

Realizacija projekata u 3D tehnologijama

Trajanje programa osposobljavanja :

50 sati

Broj bodova:

2 ECTS boda

Obrazovna područja:

Strojarsko, brodogradnja i metalurgija Elektrotehnika i računarstvo Informacije i komunikacije

Dobiveni certifikati i značke:

Polaznik po uspješnom završetku programa prima potvrdu o sudjelovanju na osposobljavanju. Ako preda projektnu zadaću i uspješno ispuni sva predviđena vrednovanja u programu, prima mikrodokaz o provedenom osposobljavanju s popisom stečenih kompetencija i ostvarenih ishoda učenja te digitalnu otvorenu značku s opisom stečenih kompetencija i ishoda učenja koje je dokazao kako bi značku stekao.

PAGE * MERGEFORMAT3

1. Opis i ciljna skupina programa osposobljavanja:

Opis programa

Program polaznike provodi kroz cjeloviti ciklus rada s 3D tehnologijama – od digitalnog oblikovanja i 3D modeliranja, preko 3D skeniranja i digitalizacije fizičkih objekata, do planiranja i realizacije aditivne proizvodnje gotovih predmeta. Naglasak je na razumijevanju radnih procesa, pravilnoj pripremi modela i učinkovitoj provedbi 3D projekata.

Ciljna skupina

Tehničari i inženjeri u području strojarstva, mehatronike, elektrotehnike, dizajna i srodnih tehničkih struka Dizajneri i kreativni profesionalci koji rade s digitalnim modelima i fizičkim prototipima

2. Kompetencije

Kroz obuku polaznik (polaznici) razvija sljedeće profesionalne kompetencije:

Kompetencije stečene programom osposobljavanja
1. 3D modeliranje i reverzno inženjerstvo **2. Strategija i upravljanje aditivnom proizvodnjom** **3. Digitalizacija i analiza 3D skenova** **4. Planiranje i optimizacija radnih procesa**

PAGE * MERGEFORMAT3

3. Ishodi učenja

Kompetencija: **3D modeliranje i reverzno inženjerstvo**

Sudionik(i)

1.	Izraditi jednostavan 3D model mjerenjem stvarnog objekta poštujući pravila dizajna za aditivnu proizvodnju.
2.	Samostalno obaviti osnovno 3D modeliranje i rekonstrukciju 3D geometrije putem povratnog inženjerstva te samostalno koristiti softver za oblikovanje 3D modela
3.	Samostalno prilagoditi 3D geometriju za procese aditivne proizvodnje

Kompetencija: **Strategija i upravljanje aditivnom proizvodnjom**

Sudionik(i)

1.	Pripremiti i ispisati 3D model poštujući optimizaciju procesa.
2.	Pravilno odabrati materijal i tehnologiju za aditivnu proizvodnju prema traženim karakteristikama i namjeni proizvoda

3.	Pripremiti 3D model za aditivnu proizvodnju uvažavajući odabranu tehnologiju
4.	Samostalno proizvoditi izrađevine i pravilno koristiti opremu za aditivnu proizvodnju (3D ispis)

Kompetencija: **Digitalizacija i analiza 3D skenova**

Sudionik(i)

1.	Izvesti 3D skeniranje objekta s generiranim modelom i analizom mogućih grešaka.
2.	Objasniti i razlikovati temeljne principe laserskog skeniranja, tehnologiju strukturiranog svjetla te metodu fotogrametrije.
3.	Samostalno pripremiti objekt za digitalizaciju, što uključuje pravilno pozicioniranje, nanošenje antirefleksnih premaza i postavljanje referentnih oznaka (markera).
4.	Izvršiti proces skeniranja pomoću 3D skenera te primijeniti softverske alate (poput Artec Studija ili MeshLaba) za obradu, korekciju i spajanje dobivenih podataka.
5.	Prepoznati uobičajene pogreške u digitalnom zapisu tijekom procesa skeniranja te primijeniti odgovarajuće dijagnostičke metode za njihovo uklanjanje.

Kompetencija: **Planiranje i optimizacija radnih procesa**

PAGE * MERGEFORMAT3

Sudionik(i)

1.	Razraditi detaljan plan radnog procesa s procjenom resursa i kalkulacijom troškova za jedan projekt.
2.	Poštivati radne procese i adekvatno optimizirati proizvodni proces
3.	Samostalno planirati radni proces 3D modeliranja, 3D skeniranja i aditivne proizvodnje (3D ispisa) poštujući pritom zadane postupke rada i specifičnosti proizvodnje
4.	Pripremiti alate i strojeve za 3D skeniranje, 3D modeliranje i aditivnu proizvodnju (3D ispis) prema potrebama radnog procesa i sukladno zadaćama
5.	Procijeniti potrebni materijal, alat i ostale resurse za 3D postupke / procese
6.	Izračunati i obrazložiti cijenu i vrijednost poslova nadređenom ili kupcu

4. Struktura programa osposobljavanja

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Z. br.	NAZIV MODULA	BROJ BODOVA Bodovi (ECTS)	SATI (h)		
			T	PP	UKUPNO
1.	Osnove 3D modeliranja i digitalni alati	0,8	8	12	20
2.	Aditivna proizvodnja – Strategije i priprema	0,4	4	6	10
3.	3D skeniranje i digitalizacija fizičkih objekata	0,4	4	6	10
4.	Planiranje i organizacija radnih procesa u 3D tehnologijama	0,4	3	7	10
		UKUPNO	**14**	**36**	**50**

Modul 1: Osnove 3D modeliranja i digitalni alati

Ciljevi:
Osposobiti nastavnike za kritički odabir i korištenje softverskih alata za 3D modeliranje, oblikovanje i reverzno inženjerstvo.

PAGE * MERGEFORMAT

Sadržaj:

- Pregled softverskih alata za 3D modeliranje (npr. Fusion 360, Blender, Tinkercad).
- Osnove mehanike i geometrije za 3D modeliranje.
- Reverzno inženjerstvo: rekonstrukcija 3D geometrije iz fizičkih objekata.
- DfAM (Design for Additive Manufacturing): prilagodba modela za aditivnu proizvodnju.

Metode:

Dominantan nastavni sustav modula “Osnove 3D modeliranja i digitalni alati” je projektna nastava. Određeni digitalni alati i programi imaju mogućnost stvaranja virtualnih učionica u kojem nastavnik može kontrolirati i pomagati u radu polaznika. Također, postoji mogućnost kolaboracije u virtualnim učionicama gdje polaznici mogu rješavati problemske zadatke u timovima.

Tijekom realizacije teorijskih nastavnih sadržaja, nastavnik će polaznike upoznati s primjenom načela 3D modeliranja u aditivnoj proizvodnji. Koristeći izrađene primjere analizirat će se modeli te kako poboljšati njihova fizikalna svojstva.

Aktivnost i sudjelovanje polaznika je uključeno kroz odgovore na pitanja i interpretaciju usporedivih i razumljivih praktičnih primjera s temom predavanja.

Na vježbama nastavnik prikazuje i objašnjava praktične zadatke uz demonstraciju. Polaznici će stečena teorijska znanja primjenjivati praktično prilikom 3D modeliranja uz primjenu načela 3D modeliranja u aditivnoj proizvodnji stvaranjem kompleksnih trodimenzionalnih modela proizvoda i komponenata. Na konkretnim primjerima polaznici će demonstrirati kako se model priprema za aditivnu proizvodnju te kako poboljšati fizikalna svojstva modela.

Nastavnik ima ulogu mentora koji organizira i usmjerava aktivnosti polaznika s jasnim rokovima izvršavanja. Pri izvođenju praktičnih vježbi preporuča se polaznike rasporediti u parove ili timove te im odrediti uloge unutar tima.

Polaznik se postupno uvodi u svijet rada te mu se omogućuje sudjelovanje u radnome procesu u kontroliranim uvjetima sve dok ne stekne potpune kompetencije za samostalan rad.

Samostalne aktivnosti polaznika uključuju rješavanje zadanih projektnih zadataka primjenom stečenih znanja te samostalno proučavanje literature, internetskih izvora i publikacija prema preporuci nastavnika kroz koje će proširiti i produbiti svoja znanja.

Modul 2: Aditivna proizvodnja – Strategije i priprema

PAGE * MERGEFORMAT

Ciljevi:
Razumjeti i primijeniti strategije aditivne proizvodnje, pripremu modela i korištenje opreme.

Sadržaj:

- Odabir materijala i tehnologije prema karakteristikama proizvoda.
- Priprema 3D modela u sliceru (npr. Cura, PrusaSlicer) s obzirom na tehnologiju.
- Rukovanje 3D pisačima: kalibracija, postavljanje, praćenje procesa.

Metode:

Dominantan nastavni sustav u modulu “Aditivna proizvodnja – Strategije i priprema” je projektna nastava. Određeni digitalni alati i programi imaju mogućnost kolaboracije gdje polaznici mogu rješavati problemske zadatke u timovima, no sami ispis modela i puštanje pisača u pogon mora biti u specijaliziranoj učionici za aditivnu proizvodnju.

Tijekom realizacije teorijskih nastavnih sadržaja, nastavnik upoznaje polaznike sa prednostima i značajkama 3D ispisa te s postupcima, tehnikama i alatima.

Na vježbama nastavnik prikazuje i objašnjava praktične zadatke uz demonstraciju.

Polaznici će stečena teorijska znanja primjenjivati praktično prilikom rješavanja projektnog zadatka što uključuje samostalno uključivanje, spajanje i podešavanje 3D printera različitih tehnologija za uspješan proces ispisa, odabir materijala i postavki u CAM programu.

Nastavnik ima ulogu mentora koji organizira i usmjerava aktivnosti polaznika s jasnim rokovima izvršavanja. Pri izvođenju praktičnih vježbi preporuča se polaznike rasporediti u parove ili timove te im odrediti uloge unutar tima.

Polaznik se postupno uvodi u svijet rada te mu se omogućuje sudjelovanje u radnom procesu u kontroliranim uvjetima sve dok ne stekne potpune kompetencije za samostalan rad.

Samostalne aktivnosti polaznika uključuju rješavanje zadanih projektnih zadataka primjenom stečenih znanja te samostalno proučavanje literature, internetskih izvora i publikacija prema preporuci nastavnika kroz koje će proširiti i produbiti svoja znanja.

Modul 3: 3D skeniranje i digitalizacija fizičkih objekata

Cilj:
Savladati tehnike 3D skeniranja, pripreme objekata i dijagnostike pogrešaka.

Sadržaj:

PAGE * MERGEFORMAT

- Teorijske osnove 3D skeniranja (lasersko, struktuirano svjetlo, fotogrametrija).
- Priprema objekta za skeniranje: pozicioniranje, premazi, oznake.
- Korištenje skenera i softvera za obradu (npr. Artec Studio, MeshLab).
- Prepoznavanje i rješavanje problema tijekom skeniranje.

Metode:
Dominantan oblik rada je praktična radionica i projektno učenje. Nastavnik demonstrira različite tehnike skeniranja te vodi polaznike kroz proces digitalizacije objekata. Polaznici će u grupama izvesti skeniranje jednostavnih objekata koristeći dostupne 3D skenere i programske alate. Tijekom vježbi analizirat će kvalitetu skenova, prepoznati pogreške i primijeniti korektivne metode. Uloga nastavnika je mentorska — usmjerava rad, kontrolira postupke i osigurava točnost rezultata. Polaznici izrađuju dokumentaciju procesa, opisuju korištene metode i prezentiraju konačni 3D model.

Samostalne aktivnosti uključuju istraživanje primjene 3D skeniranja u različitim područjima (obrazovanje, industrija, medicina) te analizu primjera iz prakse.

Modul 4: Planiranje i organizacija radnih procesa u 3D tehnologijama

Cilj:
Naučiti planirati, optimizirati i organizirati resurse za 3D postupke.

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Sadržaj:

- Optimizacija proizvodnog procesa: vrijeme, troškovi, kvaliteta.
- Planiranje rada za 3D modeliranje, skeniranje i ispis.
- Priprema alata, strojeva i materijala.
- Procjena potrebnih resursa i kalkulacija troškova.

Metode:

U ovom modulu koristi se problemska i projektna nastava. Polaznici u timovima analiziraju realne proizvodne zadatke i izrađuju planove procesa s naglaskom na učinkovitost i troškovnu optimizaciju. Nastavnik demonstrira načine planiranja i praćenja projekata koristeći digitalne alate (npr. Trello, Excel). Polaznici primjenjuju znanja na konkretnom primjeru planiranja projekta koji uključuje sve faze 3D postupka — od ideje do gotovog proizvoda. Samostalni rad uključuje analizu troškova, izrađene planove te evaluaciju procesa. Nastavnik ima ulogu mentora koji usmjerava rad i provjerava točnost kalkulacija.

5. Način izvedbe

Obrazovanje se provodi u kombiniranoj radionici i online učionici:

PAGE * MERGEFORMAT3

- **1.** dan uživo 4 sata
- **2.** dan uživo 4 sata
- **Rad u online učionici (videozapisi, problemski zadaci, forum, izrada i predaja samostalnog projekta) – 12 Sati**
- **3.** dan uživo 4 sata
- **Rad u online učionici (videozapisi, problemski zadaci, forum, izrada i predaja samostalnog projekta) – 6 Sati**
- **4.** dan uživo 4 sata
- **Rad u online učionici (videozapisi, problemski zadaci, forum, izrada i predaja samostalnog projekta) – 6 Sati**
- **5.** dan uživo - **3 Sata**
- **6.** dan uživo - **3 Sata**
- **Rad u online učionici (videozapisi, problemski zadaci, forum, izrada i predaja samostalnog projekta) – 2 Sata**
- **7.** dan uživo u radionici - prezentacija samostalnih projekata i evaluacija - **2 Sata**

Metode poučavanja: objašnjenje, rasprava, učenje temeljeno na problemima, praktične vježbe, projektni zadatak.

6. Procjena znanja

Usvojenost se provjerava kroz praktične provjere znanja i predstavljanje rada.

Praktičnom provjerom znanja provjeravaju se sve X kompetencije programa:

- **3D modeliranje i reverzno inženjerstvo**
- **Strategija i upravljanje aditivnom proizvodnjom**
- **Digitalizacija i analiza 3D skenova**
- **Planiranje i optimizacija radnih procesa**

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Praktična provjera znanja se održava u tri dijela:

1. **Planiranje, dizajn i izrada proizvoda**
2. **prezentacija procesa i rezultata,**
3. **odgovaranje pred Povjerenstvom.**

1. Planiranje, dizajn i izrada proizvoda (digitalni + fizički dio)

- Kandidat priprema strategiju 3D radnog procesa
- 3D skenira oštećeni proizvod
- Izvodi reverzno inženjerstvo 3D modeliranja
- Podešava parametre u sliceru ovisno o zahtjevima
- Odabire materijal ovisno o zahtjevima
- Izrađuje kalkulaciju i ponudu za proizvodni proces
- Izrađuje proizvod 3D tiskom

2. Prezentacija procesa i rezultata

Kandidat priprema **kratku prezentaciju (5-7 minuta)** koja pokazuje:

- Pristup rješavanju problemskog zadatka,
- Korištenje tehnologija i materijala,
- Obrazlaganje kalkulacije,

PAGE * MERGEFORMAT3

3. Obrana

1. Povjerenstvo postavlja studentima **pitanja o postupku**, odabranim rješenjima i mogućim poboljšanjima.
2. Kandidat odgovara na pitanja objašnjavajući razumijevanje osnovnih načela

Kriteriji ocjenjivanja:

- Planiranje radnog procesa i procjena resursa (0–2 boda)
- Priprema objekta za skeniranje (0–2 boda)
- Kvaliteta 3D skena i analiza te obrada podataka (0–2 boda)
- Reverzno inženjerstvo 3D modeliranjem (0–2 boda)
- Prilagodba i optimizacija 3D modela (0–2 boda)
- Pohrana u formatu za 3D ispis (0–2 boda)
- Postavljanje parametara 3D pisača (0–2 boda)
- Proizvodnja 3D ispisom (0–2 boda)
- Prezentacija i obrana (0–2 boda)

Ocjene:

- 0–8 bodova: nedovoljan
- 9–13 bodova: dobar
- 14–18 bodova: Odličan

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Za dobivanje mikrokvalifikacije: min. 9 bodova (min. dobar), nijedan od kriterija ne treba ocjenjivati s 0 bodova.

Pristup Open Badge – Realizacija projekata u 3D tehnologijama

Srednja strukovna škola Velika Gorica, Ulica kralja Stjepana Tomaševića 21, 10410 Velika Gorica

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Poveznica putem web stranice: https://www.cl-bvet.eu/education-and-training/

Za dobivanje otvorene značke -Realizacija projekata u 3D tehnologijama potrebno je uspješno završiti obuku. Potrebno je predati projektni zadatak i kratku prezentaciju realizacije projekta korištenjem 3D tehnologija. Projektni zadatak i prezentacija moraju biti uspješno ocijenjeni.

PAGE * MERGEFORMAT

Izbor zadatka:

- Odaberite oštećeni proizvod te isplanirajte strategiju reverznog inženjerstva i proizvodnje novog objekta

3D skeniranje:

- Pripremiti objekt za skeniranje
- Odrediti kvalitetu 3D skena te analizirati i obraditi podatke

Reverzno inženjerstvo i 3D modeliranje:

- Izvršiti reverzno inženjerstvo 3D modeliranjem
- Prilagoditi i optimizirati 3D model sukladno zahtjevima
- Pohraniti u formatu za 3D ispis

Radni proces i kalkulacija proizvodnje:

- Procijeniti vrijeme proizvodnje, potrošnju materijala i osnovne troškove izrade

3D ispis proizvoda:

- Postaviti parametre 3D pisača i odabrati materijal sukladno zahtjevima
- Proizvesti objekt 3D ispisom

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Predstavljanje:

- Pripremite kratku prezentaciju (2-3 stranice) o pristupu rješavanja problemskog zadatka, korištenju tehnologija i materijala te izradi kalkulacije za proizvodnju s priloženim slikama oštećenog proizvoda, skena, modela i ispisanog proizvoda
- Pošaljite svoju prezentaciju na donjoj poveznici.

Datum prijave:

- **Prenesite digitalne datoteke i prezentacije na donju poveznicu najkasnije do xx.yy.zzzz**

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

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7. Metoda osiguranja kvalitete

Osiguranje kvalitete provodi se u skladu s Pravilnikom o sustavu osiguravanja kvalitete kratkih programa s mikrokvalifikacijama Srednje strukovne škole Velika Gorica

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Short education program Microqualifications (Open Badge)

Realization of projects in 3D technologies

The education program was prepared by

Vocational High School Velika Gorica

Ivan Živković, Marin Širol

Experts:

Ivan Živković

Educational program providers

Project: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Project partners: School center Novo mesto, Euroskill doo (Slovenia), Secondary Vocational School Velika Gorica (Croatia), Technical School Gradiška, Center for Adult Education Banja Luka (Bosnia and Herzegovina), Secondary Vocational School Pljevlja, Innovative Entrepreneurial Center Tehnopolis (Montenegro)

PAGE * MERGEFORMAT

Basic information about the training program

Name of training program:

Realization of projects in 3D technologies

Duration of the training program:

50 hours

Number of points:

2 ECTS credits

Educational areas:

Mechanical engineering, shipbuilding and metallurgy Electrical engineering and computing Information and communications

Certificates and badges obtained:

Upon successful completion of the program, the participant receives a certificate of participation in the training. If they submit the project assignment and successfully complete all the assessments provided in the program, they receive micro-evidence of the training completed with a list of acquired competences and achieved learning outcomes, and a digital open badge with a description of the acquired competences and learning outcomes that they demonstrated in order to earn the badge.

PAGE * MERGEFORMAT3

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1. Description and target group of the training program:

Program description

The program takes participants through the complete cycle of working with 3D technologies – from digital design and 3D modeling, through 3D scanning and digitization of physical objects, to the planning and implementation of additive manufacturing of finished objects. The emphasis is on understanding work processes, proper model preparation, and efficient implementation of 3D projects.

Target group

Technicians and engineers in the fields of mechanical engineering, mechatronics, electrical engineering, design and related technical professions Designers and creative professionals working with digital models and physical prototypes

2. Competencies

Through the training, the participant(s) develops the following professional competencies:

Competencies acquired through the training program
1. 3D modeling and reverse engineering **2. Strategy and management of additive manufacturing** **3. digitization and analysis of 3D scans** **4. Planning and optimization of work processes**

PAGE * MERGEFORMAT3

3. Learning outcomes

Competence: **3D modeling and reverse engineering**

Participant(s)

1.	Create a simple 3D model by measuring a real object while following design rules for additive manufacturing.
2.	Independently perform basic 3D modeling and reconstruction of 3D geometry through reverse engineering and independently use software for designing 3D models
3.	Independently adjust 3D geometry for additive manufacturing processes

Competence: **Strategy and management of additive manufacturing**

Participant(s)

1.	Prepare and print a 3D model while respecting process optimization.

2.	Correctly select the material and technology for additive manufacturing according to the required characteristics and purpose of the product
3.	Prepare a 3D model for additive manufacturing, respecting the chosen technology
4.	Independently produce products and properly use additive manufacturing equipment (3D printing)

Competence : **digitization and analysis of 3D scans**

Participant(s)

1.	Perform a 3D scan of the object with the generated model and analysis of possible errors.
2.	Explain and differentiate the basic principles of laser scanning, structured light technology, and the photogrammetry method.
3.	Independently prepare the object for digitization, which includes proper positioning, application of anti-reflective coatings and placement of reference marks (markers).
4.	Perform the scanning process using a 3D scanner and apply software tools (such as Artec Studio or MeshLab) to process, correct and combine the obtained data.
5.	Recognize common errors in digital recording during the scanning process and apply appropriate diagnostic methods to eliminate them.

PAGE * MERGEFORMAT3

Competence : **Planning and optimization of work processes**

Participant(s)

1.	Develop a detailed work process plan with resource estimates and cost calculations for a single project.
2.	Respect work processes and adequately optimize the production process
3.	Independently plan the work process of 3D modeling, 3D scanning and additive manufacturing (3D printing), while respecting the given work procedures and production specifics
4.	Prepare tools and machines for 3D scanning, 3D modeling and additive manufacturing (3D printing) according to the needs of the work process and in accordance with the tasks
5.	Assess the required materials, tools and other resources for 3D procedures/processes
6.	Calculate and explain the price and value of jobs to a superior or customer

4. Training program structure

Z. no.	MODULE NAME	NUMBER OF POINTS Credits (ECTS)	HOURS (h)		
			T	PP	TOTAL
1.	Basics of 3D modeling and digital tools	0.8	8	12	20
2.	Additive manufacturing – Strategies and preparation	0.4	4	6	10
3.	3D scanning and digitization of physical objects	0.4	4	6	10
4.	Planning and organization of work processes in 3D technologies	0.4	3	7	10
		TOTAL	**14**	**36**	**50**

Module 1: Basics of 3D modeling and digital tools

PAGE * MERGEFORMAT3

Objectives:
To train students in the critical selection and use of software tools for 3D modeling, design and reverse engineering.

Contents :

- Overview of 3D modeling software tools (eg Fusion 360, Blender, Tinkercad).
- Fundamentals of mechanics and geometry for 3D modeling.
- Reverse engineering: reconstruction of 3D geometry from physical objects.
- DfAM (Design for Additive Manufacturing): adaptation of models for additive manufacturing.

Methods:

The dominant teaching system of the module “Basics of 3D Modeling and Digital Tools” is project-based teaching. Certain digital tools and programs have the ability to create virtual classrooms in which the teacher can control and assist the work of the students. There is also the possibility of collaboration in virtual classrooms where students can solve problem tasks in teams.

During the realization of theoretical teaching content, the teacher will introduce the participants to the application of 3D modeling principles in additive manufacturing. Using created examples, the models will be analyzed and how to improve their physical properties.

Student activity and participation is included through answers to questions and interpretation of comparable and understandable practical examples related to the lecture topic.

During the exercises, the teacher shows and explains practical tasks with a demonstration. Participants will apply the acquired theoretical knowledge practically during 3D modeling with the application of the principles of 3D modeling in additive manufacturing by creating complex three-dimensional models of products and components. Using concrete examples, participants will demonstrate how to prepare a model for additive manufacturing and how to improve the physical properties of the model.

The teacher has the role of a mentor who organizes and directs the activities of the participants with clear deadlines. When performing practical exercises, it is recommended to divide the participants into pairs or teams and assign them roles within the team.

The student is gradually introduced to the world of work and is allowed to participate in the work process under controlled conditions until he or she acquires full competence for independent work.

Students' independent activities include solving given project tasks by applying acquired knowledge and independent study of literature, internet sources and publications as recommended by the teacher, through which they will expand and deepen their knowledge.

Module 2: Additive manufacturing – Strategies and preparation

Objectives : Understand and apply additive manufacturing strategies, model preparation, and equipment use.

Content:

- Selection of materials and technology according to product characteristics.
- Preparation of 3D models in a slicer (eg Cura, PrusaSlicer) with regard to technology.
- Operating 3D printers: calibration, setup, process monitoring.

Methods:

The dominant teaching system in the module “Additive manufacturing – Strategies and preparation” is project-based teaching. Certain digital tools and programs have the ability to collaborate where participants can solve problem tasks in teams, but the actual printing of the model and commissioning of the printer must take place in a specialized classroom for additive manufacturing.

During the implementation of theoretical teaching content, the teacher introduces students to the advantages and features of 3D printing, as well as to the procedures, techniques, and tools.

During the exercises, the teacher presents and explains practical tasks with a demonstration. Participants will apply the acquired theoretical knowledge practically when solving a project task, which includes independently turning on, connecting and adjusting 3D printers of various technologies for a successful printing process, selecting materials and settings in the CAM program.

The teacher has the role of a mentor who organizes and directs the activities of the participants with clear deadlines. When performing practical exercises, it is recommended to divide the participants into pairs or teams and assign them roles within the team.

The participant is gradually introduced to the world of work and is allowed to participate in the work process under controlled conditions until they acquire full competence for independent work.

Students' independent activities include solving given project tasks by applying acquired knowledge and independent study of literature, internet sources and publications as recommended by the teacher, through which they will expand and deepen their knowledge.

Module 3: 3D scanning and digitization of physical objects

Objective:
To master the techniques of 3D scanning, object preparation and error diagnostics.

Content:

- Theoretical foundations of 3D scanning (laser, structured light, photogrammetry).
- Preparing the object for scanning: positioning, coatings, markings.
- Using scanners and processing software (eg Artec Studio, MeshLab).
- Identifying and resolving problems during scanning.

Methods:

The dominant form of work is a practical workshop and project-based learning. The teacher demonstrates various scanning techniques and guides the participants through the process of digitizing objects. In groups, the participants will scan simple objects using available 3D scanners and software tools. During the exercises, they will analyze the quality of the scans, identify errors and apply corrective methods. The teacher's role is that of a mentor — he directs the work, controls the procedures and ensures the accuracy of the results. The participants create documentation of the process, describe the methods used and present the final 3D model.

Independent activities include research into the application of 3D scanning in various fields (education, industry, medicine) and analysis of examples from practice.

Module 4: Planning and organization of work processes in 3D technologies

Objective:
Learn to plan, optimize and organize resources for 3D procedures.

Content:

- Optimization of the production process: time, costs, quality.
- Work planning for 3D modeling, scanning and printing.
- Preparation of tools, machines and materials.
- Estimation of required resources and cost calculation.

Methods:

In this module, problem-based and project-based teaching is used. Participants in teams analyze real production tasks and create process plans with an emphasis on efficiency and cost optimization. The teacher demonstrates ways of planning and monitoring projects using digital tools (eg Trello, Excel). Participants apply their knowledge on a concrete example of project planning, which includes all phases of the 3D process — from the idea to the finished product. Independent work includes cost analysis, developed plans and process evaluation. The teacher has the role of a mentor who directs the work and checks the accuracy of the calculations.

PAGE * MERGEFORMAT

5. **Method of execution**

Education is conducted in a combined workshop and online classroom:

- **Day 1** live - 4 hours
- **Day 2** live - 4 hours
- **Work in the online classroom (videos, problem tasks, forum, creation and submission of an independent project) – 12 hours**
- **Day 3** Live - 4 hours
- **Work in the online classroom (videos, problem tasks, forum, creation and submission of an independent project) – 6 hours**
- **Day 4** Live - 4 hours
- **Work in the online classroom (videos, problem tasks, forum, creation and submission of an independent project) – 6 hours**
- **Day 5 Live - 3 Hours**
- **Day 6** Live - **3 Hours**

- **Work in the online classroom (videos, problem tasks, forum, creation and submission of an independent project) – 2 hours**
- **Day 7** live in the workshop - presentation of independent projects and evaluation - **2 Hours**

Teaching methods: explanation, discussion, problem-based learning, practical exercises, project assignment.

6. Knowledge assessment

Adoption is checked through practical knowledge tests and presentation of work .

Practical knowledge testing tests all X competencies of the program:

- **3D modeling and reverse engineering**
- **Strategy and management of additive manufacturing**
- **digitization and analysis of 3D scans**
- **Planning and optimization of work processes**

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The practical knowledge test is held in three parts:

1. **Planning, design and production of products**
2. **presentation of process and results,**
3. **answering before the Commission.**

1. Planning, design and production of products (digital + physical part)

- The candidate prepares a 3D work process strategy
- 3D scans the damaged product
- Performs reverse engineering of 3D modeling
- Adjusts parameters in the slicer depending on requirements
- Selects material depending on requirements
- Creates a calculation and offer for the production process
- Creates a product using 3D printing

2. Presentation of the process and results

The candidate prepares **a short presentation (5-7 minutes)** that shows:

- Approach to solving a problem task,
- Use of technologies and materials,
- Explanation of the calculation

PAGE * MERGEFORMAT3

3. Defense

1. The committee asks students **questions about the process**, the chosen solutions, and possible improvements.
2. The candidate answers questions explaining their understanding of the basic principles

Evaluation criteria:

- Work process planning and resource estimation (0–2 points)
- Preparing the object for scanning (0–2 points)
- Quality of 3D scan and analysis and data processing (0–2 points)
- Reverse engineering with 3D modeling (0–2 points)
- 3D model adaptation and optimization (0–2 points)
- Storage in 3D printing format (0–2 points)
- Setting 3D printer parameters (0–2 points)
- 3D printing production (0–2 points)
- Presentation and defense (0–2 points)

Grades:

- 0–8 points: insufficient
- 9 –1 3 points: good

- 1 4 –1 8 points: Excellent

To obtain a micro-qualification: min. 9 points (min. good), none of the criteria should be rated with 0 points.

Open Badge approach - Realization of projects in 3D technologies

Secondary Vocational School Velika Gorica, Ulica kralja Stjepana Tomaševića 21, 10410 Velika Gorica

Project: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Website link: https://www.cl-bvet.eu/education-and-training/

To obtain an open badge - Realization of projects in 3D technologies it is necessary to successfully complete the training. It is necessary to submit the project task and a short presentation of the project realization using 3D technologies. The project assignment and presentation must be successfully evaluated.

PAGE * MERGEFORMAT3

Task selection:

● Select the damaged product and plan a reverse engineering strategy and manufacture a new object

3D scanning:

● Prepare the object for scanning ● Determine the quality of 3D scans and analyze and process the data

Reverse engineering and 3D modeling:

● Perform reverse engineering with 3D modeling ● Customize and optimize the 3D model according to requirements ● Save in 3D printable format

Work process and production calculation:

● Estimate production time, material consumption and basic manufacturing costs

3D printing of products:

● Set 3D printer parameters and select material according to requirements ● Produce an object by 3D printing

Presentation:

- Prepare a short presentation (2-3 pages) about the approach to solving the problem task, the use of technologies and materials, and the creation of a calculation for production with attached images of the damaged product, scans, models and the printed product
- Submit your presentation at the link below.

Application date:

- **Upload digital files and presentations to the link below no later than xx.yy.zzzz**

https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

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7. Quality assurance method

Quality assurance is carried out in accordance with the Regulations on the Quality Assurance System for Short Programmes with Microqualifications of the Velika Gorica Secondary Vocational School

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Short Training programme *Microcredentials (Open Badge)*

IMPLEMENTATION OF PLC IN AUTOMATIC CONTROL IN INDUSTRY

Trening programme prepared by:

PI Technical school Gradiška

Expert team members:

Dragan Milivojša
Srdjan Djukanović
Vlado Tomić
Duška Straživuk

Training programme initiators:

Project: *CL_BVET EDUCATION AND TRAINING FOR COLLABORATIVE LEARNING IN BLENDED LEARNING ENVIRONMENTS*

Partners of project: JU Tehnička škola Gradiška, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna škola Velika Gorica (Croatia), Srednja stručna škola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro).

BASIC INFORMATION ABOUT TRAINING PROGRAMME

Tittle training programme:

Implementation PLC in automatic control in industry

Duration of programme:

50 [*hours*]

Credit value:

3 *ECTS*

Educational fields:

• Automation of industrial systems • Programming and application of PLCs • Mechatronics and automatic process control • Maintenance and diagnostics of automated systems • Digital technologies in industrial production

Awards and certificates:

Upon successful completion of the programme "Implementation of PLCs in Automatic Control in Industry", participants receive a certificate of completion, confirming the acquisition of knowledge and skills in the fields of industrial automation and process control using PLC systems. In addition to the certificate, participants are awarded an Open Badge as a digital confirmation of acquired skills. The Open Badge enables verification of knowledge in digital form and its sharing on professional platforms. The certificate and Open Badge confirm the participant's qualification to perform the relevant tasks.

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1. DESCRIPTION AND TARGET GROUP OF THE TRAINING PROGRAMME

Programme Description:

The aim of the programme "Implementation of PLCs in Automatic Control in Industry" is to qualify participants for the independent use of modern industrial automation technologies through working with PLC systems, HMI interfaces, and the preparation of technical documentation within industrial processes.

The programme focuses on enhancing the digital and professional competencies of participants, particularly in the use of software tools for programming and managing automated systems, as well as their practical application on real industrial equipment.

Special emphasis is placed on developing skills in planning, organising, and executing automated processes, while linking theoretical knowledge with practical application in modern industrial environments.

Target group:

The target group of this training programme includes vocational school students and university students in the fields of electrical engineering, mechatronics, robotics, and industrial automation, as well as technicians employed in production and industrial maintenance systems who wish to improve their knowledge and skills in PLC programming and industrial process control.
The programme is also intended for unemployed and employed individuals who wish to acquire or further enhance competencies in the fields of industrial automation, PLC programming, and industrial process control. It is particularly suitable for technicians, production operators, electricians, mechatronic engineers, and individuals who already work or plan to work in industrial automation systems.
Furthermore, the course is aimed at participants who wish to improve their digital competencies and qualify for working with modern software tools and equipment in an industrial production environment.

2. SKILLS

Upon completion of the programme, participants will be qualified to:

- Understand and apply foundational knowledge
- Configure and programme PLC systems and microcontrollers in industrial automation
- Use software tools for programming, simulation, and monitoring of PLC systems
- Operate HMI systems for visualisation, monitoring, and control of automated processes
- Diagnose faults and solve problems in real time
- Develop and document technical solutions through documentation
- Work on improving existing production processes

3. LEARNING OBJECTIVES

Skill 1: **Understanding and Applying Foundational Knowledge**

Objectives:

• recognise and explain basic electrical quantities and electronic components;
• perform basic measurements of voltage, current, and resistance;
• analyse simple electrical and digital circuits;
• use simulation tools to verify the operation of electronic circuits;
• understand the basic principles of automatic control (open and closed loop);
• connect mathematical and technical process models with real industrial systems;
• use sensor signals and understand their effect on the control logic of the system;
• explain the basic operating principles of PLCs and industrial automation systems;
• configure and programme a PLC in accordance with the requirements of industrial processes;

Skill 2: **Configuration and Programming of PLC Systems and Microcontrollers in Industrial Automation**

Objectives:

• use PLC software tools for creating and editing control programmes (Mitsubishi Alpha, Siemens LOGO, Schneider Zelio, EasySoft, EMCO Ipertu);
• write and test programmes through simulation tools on microcontrollers prior to implementation on a real system;
• optimise the basic components of the system in order to adequately monitor it and perform supervisory control via the PLC, with the aim of achieving system autonomy;

Skill 3: **Using Software Tools for PLC Programming, Simulation, and Monitoring**

Objectives:

- monitor PLC system operation via HMI/SCADA or monitoring software;
- document and store programming solutions using standard digital tools and procedures;
- optimise and adapt programmes based on simulation results and real-world system performance;

Skill 4: **Operating HMI Systems for Visualisation, Monitoring, and Control of Automated Processes**

Objectives:

- explain the role of HMI systems in industrial automation;
- create basic HMI screens for process display;
- connect an HMI with a PLC system;
- monitor and control a process via an HMI interface;

Skill 5: **Fault Diagnostics and Real-Time Problem Solving**

Objectives:

- use diagnostic tools to identify faults;
- recognise and analyse errors in the operation of automated processes;
- interpret alarm messages, signals, and logs in real time;
- respond to system malfunctions in order to minimise production downtime;
- apply systematic fault-elimination methods in industrial systems;
- collaborate with the team to resolve technical problems efficiently;

Skill 6: **Development and Documentation of Technical Solutions**

Objectives:

- produce electrical and pneumatic diagrams using appropriate software tools;
- document PLC programming solutions;
- prepare a technical description of the implemented system;
- present and archive project documentation in accordance with the assignment;

Skill 7: **Improving Existing Production Processes**

Objectives:

- analyse existing production processes to identify shortcomings and improvement opportunities;
- propose and implement measures to increase system efficiency and productivity;
- optimise workflows by adjusting PLC logic and control parameters;
- evaluate the results of improvements by monitoring system performance and production indicators;

4. PROGRAMME STRUCTURE

No.	Title of Module	Credits (ECTS)	No. hours (h)		
			T	P	TOTAL
1.	Fundamentals of Electrical Engineering and Electronics	0,5	2	1	3
2.	Microcontrollers	0,5	2	3	5
3.	The Concept of PLC – Programmable Logic Controller	0,5	2	3	5
4.	Solving Electro-Pneumatic Control Problems	0,5	2	3	5
5.	Using PLCs in Industrial Production	0,5	1	4	5
6.	Technical Documentation	0,5	2	0	2
		TOTAL	**11**	**14**	**25**

MODULE 1: FUNDAMENTALS OF ELECTRICAL ENGINEERING AND ELECTRONICS

Objective: To introduce participants to the basic concepts of electrical engineering and electronics (voltage, current, resistance, power, analogue and digital signals) and to develop foundational skills for working with and analysing electrical and electronic circuits through simulation and practical examples.

Content:

- Basic electrical concepts: voltage, current, resistance, and power;
- Measurement of voltage and current in electrical circuits;
- Series and parallel connection of resistors and capacitors (simulation – Falstad Circuit Simulator);
- Determination of resistor values (colour bands and measurement);
- Operating principle of electromagnets and relays;
- Logic gates, flip-flops, timers, counters, and adders (LogiSIM, Falstad);
- Reading and producing electrical diagrams (LibreCAD, AutoCAD);

Methods:

The programme is delivered through interactive lectures, demonstrations of electrical and electronic circuit operation, software simulations, practical measurement exercises, individual and group work, and problem-solving using concrete practical examples. Special emphasis is placed on learning through simulation and the practical application of basic electronic principles.

MODULE 2: MICROCONTROLLERS

Objective:
To qualify participants for the practical application of digital electronics through work with microcontrollers (e.g. Arduino UNO or PIC16F684), including the design, programming, and testing of simple control systems.

Content:

- Selection of equipment for implementing a simple control task;
- Creation of electrical diagrams using software (LibreCAD, QElectroTech, AutoCAD, Fritzing);
- Assembly of an electrical circuit based on the produced diagram;
- Programming of microcontrollers (C language, Arduino, OpenPLC, FLProg);
- Fundamentals of machine code, high-level programming languages, assemblers, and compiler operation;
- Testing and verification of the completed electronic circuit;

Methods:
Instruction is delivered through a combination of interactive lectures, demonstrations of microcontroller system operation, practical laboratory exercises, programming assignments, simulations, and independent participant work. Special focus is placed on learning through practical implementation and testing of the functionality of completed solutions under real or simulated conditions.

MODULE 3: **THE CONCEPT OF PLC – PROGRAMABILE LOGIC CONTROLLER**

Objective:

To familiarise participants with the structure and operating principles of PLC systems, the basic programming languages used for PLC programming, and the application of HMI interfaces in industrial automated systems.

Content:

- Theoretical foundations of PLC systems (CPU, input/output modules, communication modules);
- Programming languages for PLC (Ladder Diagram – LD, Function Block Diagram – FBD, Structured Text – ST, Sequential Function Chart – SFC);
- Working with PLC programming software (Siemens LOGO, TIA Portal, ZelioSOFT, Mitsubishi ALPHA, EATON EasySoft);
- Simulation of PLC programme operation;
- Basic principles of HMI control and process visualisation;

Methods:

Instruction is delivered through interactive lectures, PLC system demonstrations, practical programming exercises, simulations of control processes, work on concrete industrial automation examples, and individual and group work. Special emphasis is placed on the practical application of PLC programmes and an understanding of their role in real industrial systems.

MODULE 4: **SOLVING ELECTRO-PNEUMATIC CONTROL PROBLEMS**

Objective:
To qualify participants to identify and apply electro-pneumatic components, produce electro-pneumatic diagrams, and solve simple control tasks in industrial systems.

Content:

- Basic electrical and pneumatic components and their function in automated systems;
- Operating principle of electro-pneumatic systems;
- Drawing electro-pneumatic diagrams;
- Logical problem-solving of control tasks using relay technology;
- Simulation of electro-pneumatic systems using appropriate software (e.g. FluidSIM);
- Assembly and connection of pneumatic and electrical circuits;
- Testing and verification of system functionality;

Methods:

Instruction is delivered through interactive lectures, demonstrations of electro-pneumatic component operation, simulations using specialised software, laboratory exercises, practical work on equipment, and problem-solving tasks. Special emphasis is placed on connecting theoretical knowledge with practical implementation.

MODULE 5: **USING PLC-s IN INDUSTRIAL PRODUCTION**

Objective:
To qualify participants to integrate acquired knowledge in the fields of PLC programming and electro-pneumatic control through the development and implementation of a functional solution for the automation of an industrial process.

Content:

- Analysis and resolution of a given electro-pneumatic control problem;
- Development of a pneumatic system diagram;
- Development of an electrical control diagram;
- Development of a PLC control programming solution;
- Implementation and configuration of HMI process visualisation;
- Connection of the PLC with input/output devices and pneumatic components;
- Testing, optimisation, and commissioning of the system;
- Documentation of the implemented solution;

Methods:

Instruction is delivered through project work, practical laboratory exercises, demonstrations on industrial equipment, simulations of control processes, and problem-solving tasks.

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Participants independently and in teams develop and implement functional solutions using PLC controllers, HMI devices, and electro-pneumatic components. Special emphasis is placed on the practical application of acquired knowledge under conditions that simulate real industrial processes.

MODULE 6: **TECHNICAL DOCUMENTATION**

Objective:
To qualify participants for the preparation and presentation of technical documentation accompanying the implementation of an automated industrial system based on PLC control.

Sadržaj:

- Preparation of a pneumatic solution diagram;
- Preparation of an electrical control diagram using relay technology;
- Preparation of an electrical wiring diagram for the PLC and associated components;
- Documentation of the software solution using Ladder Diagram (LD) and Function Block Diagram (FBD) programming languages;
- Preparation of a technical description of the implemented system;
- Preparation and archiving of project documentation;
- Recording and documentation of the completed pneumatic and PLC system;
- Presentation of the completed project assignment;

Methods:
Instruction is delivered through practical work on technical documentation, individual project assignments, demonstrations of best practice examples, work with CAD and PLC software tools, and mentored guidance during the preparation of the final documentation. Special emphasis is placed on accuracy, clarity, and the professional preparation of technical documentation in accordance with the requirements of industrial practice.

5. METHOD OF DELIVERY

The training programme is delivered in a classroom, in an automation laboratory using real systems, and online.

The programme is delivered through a blended learning approach, with a total duration of 50 hours, spread over 10 days at 5 hours per day.

The programme comprises:

- **20 hours** of classroom instruction, covering theoretical lectures, demonstrations, and discussions on the fundamental principles relating to the variables used in practice. Instruction integrates theoretical system analysis to prepare participants for subsequent training.
- **20 hours** of practical hands-on laboratory work using equipment, covering the implementation of exercises, programming, and simulation of work tasks. This also includes testing and diagnostics of existing automated systems.
- **10 hours** of guided distance learning (online) via an e-learning platform, covering independent study and analysis of course materials. This component is also intended for consultations with a mentor, where questions beyond the scope of shared learning may be raised.

By combining theoretical instruction, hands-on laboratory work, and guided distance learning, participants acquire the knowledge and skills required for applying PLC systems in modern industrial processes.

Training methods:
Active learning methods are applied throughout the programme, enabling participants to connect theoretical knowledge with practical application in the preparation and implementation of projects. Training includes interactive lectures, demonstrations, guided discussions, case study work, practical exercises, individual and group work, and the completion of project assignments. Within the guided distance learning component, digital educational materials, self-study tasks, online consultations, and knowledge assessment activities are used. Special emphasis is placed on practical work and the application of acquired competencies to real-world examples from project practice.

6. KNOWLEDGE AND SKILLS ASSESSMENT

The assessment of participants' knowledge and skills is carried out through a practical examination and the defence of a final project assignment.

The practical examination assesses the following skills:

- application of foundational knowledge in electrical engineering, industrial automation, and control systems;
- preparation and analysis of electrical and electro-pneumatic diagrams;
- programming and configuration of PLC devices using appropriate programming languages and software tools;
- preparation and implementation of HMI process visualisation;
- integration of PLCs, sensors, actuators, and other industrial components into a functional automated system;
- use of simulation and diagnostic tools to verify system operation;
- fault diagnostics and optimisation of automated process operation;
- preparation of technical documentation and presentation of the implemented solution.

Through the defence of the final project assignment, participants demonstrate their ability to plan, implement, test, and document an automated control system based on PLC technology.

The practical examination is conducted in three parts:

1. Completion of the project assignment (industrial automated system), which includes:

- analysis of a given problem from the field of industrial automation;
- preparation of an electrical and/or electro-pneumatic system diagram;
- development of a PLC programming solution;
- preparation of HMI process visualisation;
- testing, diagnostics, and optimisation of system functionality;
- preparation of basic technical documentation.

2**. Presentation of the development process and results** of the project assignment, along with an explanation of the chosen technical solution, components used, and system operation.

3. **Answering questions from the Examination Board** to verify understanding of PLC system operating principles, industrial communications, electro-pneumatic control, HMI visualisation, technical documentation, and the application of automation in industrial production.

7. GRADING CRITERIA

The assessment of participants' knowledge and skills is carried out according to the following criteria.

Each criterion is assessed on a scale from 0 to 2 points, with a maximum total score of 14 points [max. 14].

ASSESSMENT CRITERIA:

- Analysis of the assigned task and understanding of the system automation requirements
- Quality of the electrical and pneumatic diagram
- Correctness and functionality of the PLC programming solution
- Quality and functionality of the visualisation on one of the systems (HMI, TouchPanel)
- System testing on equipment and in a simulation environment
- Quality and neatness of technical documentation
- Quality of presentation, professional communication, and responses to Examination Board questions

Each criterion is assessed as follows:

0 – criterion not met
1 – criterion partially met
2 – criterion fully met

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8. CONDITIONS FOR PROGRAMME COMPLETION AND ASSESSMENT OF PERFORMANCE

A participant successfully completes the programme if they achieve a minimum of 8 points out of a possible 14 in the practical examination.

Based on the total number of points achieved, performance is determined as follows:

- **0 – 7 points – failed**
- **8 – 11 points – passed**
- **12 – 14 points – passed with distinction**

Upon completion of the programme, the participant receives a certificate of qualification for the implementation of PLCs in automatic control in industry, including the application of PLC systems, HMI visualisation, electro-pneumatic control, and the preparation of technical documentation for semi-autonomous or fully autonomous systems.

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9. PROCEDURE FOR OBTAINING AN OPEN BADGE

School Center Novo Mesto, Šegova street 112, 8000 Novo Mesto
Project: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments
Website: https://www.cl-bvet.eu/education-and-training/

To receive the Open Badge, participants must successfully complete the training programme and fulfil the following requirements:

- successful attendance and completion of the training programme;
- completion of a functional project assignment in the field of industrial automation using a PLC or similar system;
- preparation of accompanying technical documentation (electrical and pneumatic diagrams, PLC programme, and solution description);
- preparation and delivery of a short presentation of the completed project assignment;
- demonstration of the functionality of the implemented solution on equipment or in a simulation environment;
- positive assessment of the project assignment, technical documentation, and presentation by the examination board.

The Open Badge is awarded to participants who have demonstrated the competencies acquired in PLC programming, industrial automation, HMI visualisation, electro-pneumatic control, and the preparation of technical documentation through practical work and evaluation.

Task Selection:

- The participant selects or is assigned a problem from the field of industrial automation involving the application of a PLC system.
- Based on the task, the participant develops a functional solution comprising a PLC programme, an electrical and pneumatic diagram, and HMI visualisation (if required by the task).
- The use of pre-existing or previously completed solutions is not permitted.
- The project must be independently completed and documented.
- The completed project assignment and technical documentation must be submitted via the link provided below.

Presentation:

- Prepare a short presentation (7–10 slides) presenting the problem, components used, PLC programming solution, system operation, and results achieved.
- The presentation should include photographs, screenshots, or a video recording of the system in operation.
- The presentation must be submitted via the link provided below.

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Submisssion Deadline:

All digital materials (project assignment and presentation) must be submitted no later than 10 days before the date listed on the Notice Board

Application and submission link:
https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

The Open Badge is awarded to participants who successfully complete all of the above steps and whose project assignment and presentation receive a positive assessment.

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10. QUALITY ASSURANCE METHODS

QUALITY ASSURANCE IS CARRIED OUT IN ACCORDANCE WITH THE REGULATIONS ON THE QUALITY ASSURANCE SYSTEM FOR SHORT TRAINING PROGRAMMES WITH MICROCREDENTIALS (OPEN BADGE).

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Kratki program osposobljavanja *Microcredentials (Open Badge)*

IMPLEMENTACIJA PLC-OVA U AUTOMATSKOM UPRAVLJANJU U INDUSTRIJI

Trening program pripremili:

JU Tehnička škola Gradiška

Stručni tim činili:

Dragan Milivojša
Srdjan Djukanović
Vlado Tomić
Duška Straživuk

Inicijatori trening programa obuke:

Projekat: ***CL_BVET EDUCATION AND TRAINING FOR COLLABORATIVE LEARNING IN BLENDED LEARNING ENVIRONMENTS***

Partneri na projektu: JU Tehnička škola Gradiška, Centar za obrazovanje odraslih Banja Luka (Bosna i Hercegovina), Šolski center Novo mesto, Euroskill d.o.o. (Slovenija), Srednja strukovna škola Velika Gorica (Hrvatska), Srednja stručna škola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Crna Gora).

OSNOVNE INFORMACIJE O TRENING PROGRAMU

Naslov trening programa:

Implementacija PLC-ova u automatskom upravljanju u industriji

Trajanje programa:

50 [*h*]

Vrjednovanje:

3 *ECTS*

Obrazovna područja:

- Automatizacija industrijskih sistema
- Programiranje i primjena PLC-ova
- Mehatronika i automatsko upravljanje procesima
- Održavanje i dijagnostika automatizovanih sistema
- Digitalne tehnologije u industrijskoj proizvodnji

Dobijena priznanja i sertifikati:

Nakon uspješno provedenog programa "*Implementacija PLC-ova u automastkom upravljanju u industriji*" učesnici dobijaju sertifikat o završenom programu obuke kojim se potvrđuje sticanje znanja i vještina iz oblasti industrijske automatizacije i upravljanja procesima primjenom *PLC* sistema.

Pored sertifikata polaznicima se dodjeljuje *Open Badge* (*Otvoreni Bedž*) kao digitalna potvrda stečenih vještina. *Open Badge* omogućava verifikaciju znanja u digitalnom obliku i njegovo dijeljenje na profesionalnim platformama.

Sertifikat i *OpenBadge* potvrđuju osposobljenost polaznika za rad na pomenutim poslovima.

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1. OPIS I CILJNA GRUPA PROGRAMA OSPOSOBLJAVANJA

Opis programa:

Cilj programa „*Implementacija PLC-ova u automatskom upravljanju u industriji*“ je da osposobi polaznike za samostalno korišćenje savremenih tehnologija industrijske automatizacije, kroz rad sa *PLC* sistemima, *HMI* interfejsima i izradu tehničke dokumentacije u okviru industrijskih procesa.

Program je fokusiran na unapređenje digitalnih i stručnih kompetencija polaznika, naročito u oblasti primjene softverskih alata za programiranje i upravljanje automatizovanim sistemima, kao i njihovu praktičnu primjenu na realnoj industrijskoj opremi.

Poseban akcenat stavlja se na razvoj vještina planiranja, organizacije i realizacije automatizovanih procesa, uz povezivanje teorijskih znanja sa praktičnom primjenom u savremenim industrijskim okruženjima.

Ciljna grupa:

Ciljna grupa ovog trening programa obuhvata učenike stručnih škola i studente iz oblasti elektrotehnike, mehatronike, robotike i industrijske automatizacije, kao i tehničare zaposlene u proizvodnim i industrijskim sistemima održavanja koji žele da unaprijede svoja znanja i vještine u oblasti *PLC* programiranja i industrijskog upravljanja procesima.

Program je takođe namjenjen nezaposlenim i zaposlenim licima koja žele da steknu ili dodatno unaprijede kompetencije iz oblasti industrijske automatizacije, programiranja *PLC*-ova i upravljanja industrijskim procesima. Posebno je pogodan za tehničare, operatere u proizvodnji, električare, mehatroničare, kao i lica koja već rade ili planiraju da rade u sistemima industrijske automatizacije.

Pored toga, kurs je namjenjen učesnicima koji žele da unaprijede svoje digitalne kompetencije i osposobe se za rad sa savremenim softverskim alatima i opremom u industrijskom proizvodnom okruženju.

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2. VJEŠTINE

Po završetku programa, polaznik (polaznici) će biti osposobljen (i) za:

- Razumjevanje i primjena osnovnih znanja
- Podešavanje i programiranje *PLC* sistema i mikrokontrolera u industrijskoj automatizaciji
- Korištenje softverskih alata za programiranje, simulaciju i nadzor *PLC* sistema
- Upotrebljuje *HMI* sistеme za vizualizaciju, nadzor i upravljanje automatizovanim procesima
- Dijagnostika grešaka i rješavanje problema u realnom vremenu
- Izrada i dokumentovanje tehničkih rješenja kroz dokumentaciju
- Rad na unapređenju postojećih proizvodnih procesa

3. CILJEVI UČENJA

Vještina 1: **Razumjevanje i primjena osnovnih znanja**

Ciljevi:

• prepoznaje i objašnjava osnovne električne veličine i elektronske komponente;
• izvršiti osnovna mjerenja napona, struje i otpora;
• analizira jednostavna električna i digitalna kola;
• koristiti simulacione alate za provjeru rada elektronskih sklopova;
• poznaje osnovne principe automatskog upravljanja (otvorena i zatvorena petlja);
• povezuje matematičke i tehničke modele procesa sa realnim industrijskim sistemima;
• koristi signale senzora i njihov uticaj na upravljačku logiku sistema;
• objašnjava osnovne principe rada *PLC*-ova i sistema industrijske automatizacije;
• konfiguriše i programira *PLC* u skladu sa zahtjevima industrijskih procesa;

Vještina 2: **Podešavanje i programiranje PLC sistema i mikrokontrolera u industrijskoj automatizaciji**

Ciljevi:

• koristi PLC softverske alate za izradu i uređivanje upravljačkih programa (*Mitshubishi Alpha, Siemens LOGO, Schneider Zelio, EasySoft, EMCO Ipertu*);
• ispisuje i testira programe kroz simulacione alate na mikrokontrolerima, prije implementacije na realnom sistemu;

- optimizuje osnovne komponente sistema, kako bi se adekvatno pratio sistem i vršio nadzor pomoću *PLC* a sve u cilju postizanja autonomije sistema;

Vještina 3**: Korištenje softverskih alata za programiranje, simulaciju i nadzor *PLC* sistema**

Ciljevi:

• prati rad *PLC* sistema putem *HMI/SCADA* ili monitoring softvera;
• dokumentuje i čuva programska rješenja koristeći standardne digitalne alate i procedure;
• optimizuje i prilagođava programe na osnovu rezultata simulacije i rada sistema u praksi;

Vještina 4: **Upotrebljuje *HMI* sisteme za vizualizaciju, nadzor i upravljanje automatizovanim procesima**

Ciljevi:

•objasni ulogu *HMI* sistema u industrijskoj automatizaciji;
• kreira jednostavne *HMI* ekrane za prikaz procesa;
• povezati *HMI* sa *PLC* sistemom;
• prati i upravljati procesom putem *HMI* interfejsa;

Vještina 5: **Dijagnostika grešaka i rješavanje problema u realnom vremenu**

Ciljevi:

• koristi dijagnostičke alate za identifikaciju kvarova;
• prepoznaje i analizira greške u radu automatizovanih procesa;
• tumači alarmne poruke, signale i logove u realnom vremenu;
• reaguje na smetnje u radu sistema kako bi se smanjili zastoji u proizvodnji;
• primjenjuje metode sistematskog otklanjanja grešaka u industrijskim sistemima;
• sarađuje sa timom u cilju efikasnog rješavanja tehničkih problema;

Vještina 6**: Izrada i dokumentovanje tehničkih rješenja kroz dokumentaciju**

Ciljevi:

• izraditi električne i pneumatske šeme koristeći odgovarajuće softverske alate;
• dokumentovati *PLC* programsko rješenje;

• pripremiti tehnički opis realizovanog sistema; • prezentovati i arhivirati projektnu dokumentaciju u skladu sa zadatkom;

Vještina 7: **Rad na unapređenju postojećih proizvodnih procesa**

Ciljevi:

• analizira postojeće proizvodne procese radi identifikacije nedostataka i mogućnosti poboljšanja; • predlaže i primjenjuje mjere za povećanje efikasnosti i produktivnosti sistema; • optimizuje radne procese kroz podešavanje *PLC* logike i upravljačkih parametara; • procjenjuje rezultate unapređenja kroz praćenje performansi sistema i proizvodnih pokazatelja;

4. STRUKTURA PROGRAMA

No.	Naziv modula	Broj bodova (ECTS)	Broj sati (h)		
			T	P	TOTAL
1.	Osnove elektrotehnike i elektronike	0,5	2	1	3
2.	Mikrokontroleri	0,5	2	3	5
3.	Pojam PLK- Programabilni Logički Kontroler	0,5	2	3	5
4.	Rješavanje problema elektro-pneumatskog upravljanja	0,5	2	3	5
5.	Korištenje PLK u industrijskoj proizvodnji	0,5	1	4	5
6.	Tehnička dokumentacija	0,5	2	0	2
		TOTAL	**11**	**14**	**25**

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MODUL 1: OSNOVE ELEKTROTEHNIKE I ELEKTRONIKE

Cilj: Upoznati polaznike s osnovnim pojmovima iz elektrotehnike i elektronike (napon, struja, otpor, snaga, analogni i digitalni signali) te razviti osnovne vještine za rad i analizu električnih i elektronskih kola kroz simulaciju i praktične primjere.

Sadržaj:

- Osnovni električni pojmovi: napon, struja, otpor i snaga;
- Mjerenje napona i struje u električnim kolima;
- Vezivanje otpornika i kondenzatora (simulacija – *Falstad Circuit simulator*);
- Određivanje otpora otpornika (obojani prstenovi i mjerenje);
- Princip rada elektromagneta i releja;
- Logička kola, flip-flopovi, tajmeri, brojači i sabirači (*LogiSIM, Falstad*);
- Čitanje i izrada električnih šema (*LibreCAD, AutoCAD*);

Metode:

Program se realizuje kroz interaktivna predavanja, demonstracije rada električnih i elektronskih sklopova, simulacije u softverskim alatima, praktične vježbe mjerenja, individualni i grupni rad te rješavanje zadataka na konkretnim primjerima iz prakse. Poseban naglasak stavlja se na učenje kroz simulaciju i praktičnu primjenu osnovnih elektroničkih principa.

MODUL 2: MIKROKONTROLERI

Cilj: Osposobiti polaznike za praktičnu primjenu digitalne elektronike kroz rad sa mikrokontrolerima (npr. Arduino UNO ili PIC16F684), uključujući izradu, programiranje i testiranje jednostavnih upravljačkih sistema.

Sadržaj:

- Odabir opreme za realizaciju jednostavnog upravljačkog zadatka
- Izrada električne šeme u softverima (*LibreCAD, QElectroTech, AutoCAD, Fritzing*)
- Sastavljanje električnog kola prema izrađenoj šemi
- Programiranje mikrokontrolera (*C jezik, Arduino, OpenPLC, FLProg*)
- Osnove mašinskog koda, viših programskih jezika, asemblera i rada kompajlera
- Testiranje i verifikacija rada izrađenog elektronskog sklopa

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Metode:

Nastava se realizuje kroz kombinaciju interaktivnih predavanja, demonstracija rada mikrokontrolerskih sistema, praktičnih laboratorijskih vježbi, programerskih zadataka, simulacija i samostalnog rada polaznika. Poseban fokus je na učenju kroz praktičnu implementaciju i testiranje funkcionalnosti izrađenih rješenja u realnim ili simuliranim uslovima.

MODUL 3: **POJAM PLC – PROGRAMABILNI LOGIČKI KONTROLER**

Cilj: Upoznati polaznike sa strukturom i principom rada *PLC* sistema, osnovnim programskim jezicima za *PLC* programiranje, kao i primjenom *HMI* interfejsa u industrijskim automatizovanim sistemima

Sadržaj:

- Teorijske osnove *PLC* sistema (*CPU*, ulazno/izlazni moduli, komunikacioni moduli);
- Programski jezici za *PLC* (*Ladder Diagram – LD*, *Function Block Diagram – FBD*, *Structured Text – ST*, *Sequential Function Chart – SFC*);
- Rad u softverima za *PLC* programiranje (*Siemens LOGO, TIA Portal, ZelioSOFT, Mitsubishi ALPHA, EATON EasySOFT*);
- Simulacija rada *PLC* programa;
- Osnovni principi *HMI* upravljanja i vizualizacije procesa;

Metode:

Nastava se realizuje kroz interaktivna predavanja, demonstracije *PLC* sistema, praktične vježbe programiranja, simulacije upravljačkih procesa, rad na konkretnim primjerima industrijske automatizacije te individualni i grupni rad. Poseban naglasak stavlja se na praktičnu primjenu *PLC* programa i razumijevanje njihove uloge u realnim industrijskim sistemima.

MODUL 4: **RJEŠAVANJE PROBLEMA ELEKTROPNEUMATSKOG UPRAVLJANJA**

Cilj: Osposobiti polaznike za prepoznavanje i primjenu elektro-pneumatskih komponenti, izradu elektro-pneumatskih šema te rješavanje jednostavnih upravljačkih zadataka u industrijskim sistemima.

Sadržaj:

- Osnovne električne i pneumatske komponente i njihova funkcija u automatizovanim sistemima;
- Princip rada elektro-pneumatskih sistema;
- Crtanje elektro-pneumatskih šema;
- Logičko rješavanje upravljačkih zadataka korištenjem relejne tehnike;
- Simulacija elektro-pneumatskih sistema u odgovarajućem softveru (npr. *FluidSIM*);
- Izrada i povezivanje pneumatskog i električnog kola;
- Testiranje i provjera funkcionalnosti sistema;

Metode:

Nastava se realizuje kroz interaktivna predavanja, demonstracije rada elektro-pneumatskih komponenti, simulacije u specijalizovanim softverima, laboratorijske vježbe, praktičan rad na opremi i rješavanje problemskih zadataka. Poseban naglasak stavlja se na povezivanje teorijskih znanja sa praktičnom realizacijom.

MODUL 5: **KORIŠTENJE PLC-OVA U INDUSTRIJSKOJ PROIZVODNJI**

Cilj: Osposobiti polaznike za integraciju stečenih znanja iz oblasti *PLC* programiranja i elektro-pneumatskog upravljanja kroz razvoj i implementaciju funkcionalnog rješenja za automatizaciju industrijskog procesa.

Sadržaj:

- Analiza i rješavanje zadatog problema elektro-pneumatskog upravljanja;
- Izrada pneumatske šeme sistema;
- Izrada električne šeme upravljanja;
- Razvoj programskog rješenja za PLC upravljanje;
- Implementacija i konfiguracija HMI vizualizacije procesa;
- Povezivanje PLC-a sa ulazno-izlaznim uređajima i pneumatskim komponentama;
- Testiranje, optimizacija i puštanje sistema u rad;
- Dokumentovanje realizovanog rješenja;

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Metode:

Nastava se realizuje kroz projektni rad, praktične laboratorijske vježbe, demonstracije na industrijskoj opremi, simulacije upravljačkih procesa i rješavanje problemskih zadataka. Polaznici samostalno i u timovima razvijaju i implementiraju funkcionalna rješenja koristeći *PLC* kontrolere, *HMI* uređaje i elektro-pneumatske komponente. Poseban naglasak stavlja se na praktičnu primjenu stečenih znanja u uslovima koji simuliraju realne industrijske procese.

MODUL 6: **TEHNIČKA DOKUMENTACIJA**

Cilj: Osposobiti polaznike za izradu i prezentaciju tehničke dokumentacije koja prati realizaciju automatizovanog industrijskog sistema zasnovanog na *PLC* upravljanju.

Sadržaj:

- Izrada šeme pneumatskog rješenja;
- Izrada električne šeme upravljanja korištenjem relejne tehnike;
- Izrada električne šeme povezivanja *PLC*-a i pripadajućih komponenti;
- Dokumentovanje softverskog rješenja korištenjem *Ladder Diagram (LD) i Function Block Diagram (FBD)* programskih jezika;
- Priprema tehničkog opisa realizovanog sistema;
- Izrada i arhiviranje projektne dokumentacije;
- Snimanje i dokumentovanje rada realizovanog pneumatskog i *PLC* sistema;
- Prezentacija realizovanog projektnog zadatka;

Metode:

Nastava se realizuje kroz praktičan rad na izradi tehničke dokumentacije, individualne projektne zadatke, demonstracije primjera dobre prakse, rad sa *CAD* i *PLC* softverskim alatima, te mentorsko vođenje tokom pripreme završne dokumentacije. Poseban naglasak stavlja se na tačnost, preglednost i profesionalnu izradu tehničke dokumentacije u skladu sa zahtjevima industrijske prakse.

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5. NAČIN REALIZACIJE

Trening program se realizuje u učionici, u laboratoriji za automatizaciju na relanim sistemima i online.

Program se realizuje u kombinovanom načinu učenja (*blended learning*) u ukupnom trajanju od 50 časova, i to 10 dana po 5 časova dnevno.

Program obuhvata:

- **20 časova** rada u učionici, kroz teoretsku nastavu i predavanja, demonstracije i diskusije o osnovnim zakonitostima vezanim za veličine koje će se koristiti u radu. Nastava objedinjuje i teorijsku analizu sistema kako bi se učesnici mogli pripremiti za narednu obuku.
- **20 časova** praktičnog rada u laboratoriji na opremi kroz realizaciju vježbi, programiranje i simulacije radnih zadataka. Obuhvata i testiranje i dijagnostiku postojećih automatizovanih sistema.
- **10 časova** vođenog učenja na daljinu (*online*) putem platforme za e-učenje na daljinu, samostalan rad i analizu nastavnih sadržaja. Ovaj način rada namjenjen je i za eventualne konsultacije sa mentorom gdje se mogu postavljati pitanja koja prevazilaze okvire zajedničkog interesovanja.

Kombinovanjem teorijske nastave, praktičnog rada na opremi i vođenog učenja na daljinu polaznicima se omogućava sticanje znanja i vještina potrebnih za primjenu *PLC* sistema u savremenim industrijskim procesima.

Metode obuke:

U realizaciji programa primenjuju se metode aktivnog učenja koje omogućavaju povezivanje teorijskih znanja sa praktičnom primjenom u oblasti pripreme i sprovođenja EU projekata. Obuka obuhvata interaktivna predavanja, demonstracije, vođene diskusije, rad na studijama slučaja, praktične vježbe, individualni i grupni rad, kao i izradu projektnih zadataka. U okviru vođenog učenja na daljinu koriste se digitalni obrazovni sadržaji, samostalni zadaci, online konsultacije i aktivnosti za provjeru i utvrđivanje stečenih znanja. Poseban naglasak stavlja se na praktičan rad i primjenu stečenih kompetencija na realnim primjerima iz projektne prakse.

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6. PROCJENA ZNANJA I VJEŠTINA

Procjena znanja i vještina realizuje se kroz praktični ispit i odbranu završnog projektnog zadatka.

Praktičnim ispitom provjeravaju se **sljedeće vještine**:

- primjena osnovnih znanja iz elektrotehnike, industrijske automatizacije i upravljačkih sistema;
- izrada i analiza električnih i elektro-pneumatskih šema;
- programiranje i konfiguracija *PLC* uređaja korištenjem odgovarajućih programskih jezika i softverskih alata;
- izrada i implementacija *HMI* vizualizacije procesa;
- integracija *PLC*-a, senzora, aktuatora i drugih industrijskih komponenti u funkcionalan automatizovani sistem;
- korištenje simulacijskih i dijagnostičkih alata za provjeru rada sistema;
- dijagnostika grešaka i optimizacija rada automatizovanih procesa;
- izrada tehničke dokumentacije i prezentacija realizovanog rješenja.

Odbranom završnog projektnog zadatka polaznik demonstrira sposobnost planiranja, realizacije, testiranja i dokumentovanja automatizovanog upravljačkog sistema zasnovanog na *PLC* tehnologiji.

Praktični ispit odvija se u tri dijela:

1. Izrada projektnog zadatka (industrijskog automatizovanog sistema), koji obuhvata:

- analizu zadatog problema iz oblasti industrijske automatizacije;
- izradu elektro-pneumatske šeme sistema;
- izradu *PLC* programskog rješenja;
- izradu *HMI* vizualizacije procesa;
- testiranje, dijagnostiku i optimizaciju funkcionalnosti sistema;
- pripremu osnovne tehničke dokumentacije.

2. Prezentacija procesa izrade i rezultata projektnog zadatka, uz obrazloženje odabranog tehničkog rješenja, korištenih komponenti i načina rada sistema.

3. Odgovaranje na pitanja Komisije radi provjere razumijevanja principa rada *PLC* sistema, industrijskih komunikacija, elektro-pneumatskog upravljanja, *HMI* vizualizacije, tehničke dokumentacije i primjene automatizacije u industrijskoj proizvodnji.

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7. KRITERIJUM OCJENJIVANJA

Procjena znanja i vještina polaznika vrši se po sljedećim kriterijumima.

Svaki kriterijum se ocjenjuje u rasponu od **0 do 2 boda**, pri čemu maksimalan broj bodova iznosi **14** [*max. 14*].

KRITERIJUMI OCJENJIVANJA:

- Analiza postavljenog zadatka i razumijevanje zahtjeva automatizacije sistema
- Kvalitet izrade električne i pneumatske šeme
- Ispravnost i funkcionalnost *PLC* programskog rješenja
- Kvalitet i funkcionalnost vizualizacije na nekom od sistema (*HMI, TouchPanel*)
- Testiranje sistema na opremi i u simulacijskom okruženju
- Kvalitet i urednost tehničke dokumentacije
- Kvalitet prezentacije, stručna komunikacija i odgovori na pitanja Komisije

Svaki kriterijum se ocjenjuje na sljedeći način:

0 – kriterijum nije ispunjen
1 – kriterijum je djelimično ispunjen
2 – kriterijum je u potpunosti ispunjen

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8. USLOVI ZA ZAVRŠETAK PROGRAMA I USPJEŠNOST RADA

Polaznik uspješno završava program ukoliko na praktičnom ispitu ostvari najmanje 8 bodova od ukupno 14 mogućih bodova.

Na osnovu ukupnog broja ostvarenih bodova, uspjeh se utvrđuje na sljedeći način:
- **0 – 7** bodova – nije položio/la
- **8 – 11** bodova – položio/la
- **12 – 14** bodova – položio/la sa visokim uspehom

Završetkom programa polaznik stiče potvrdu o osposobljenosti za implementaciju *PLC*-ova u automatskom upravljanju u industriji, uključujući primjenu *PLC* sistema, *HMI* vizualizacije, elektro-pneumatskog upravljanja i izradu tehničke dokumentacije takvih polu ili gotovo potpuno autonomnih sistema.

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9. POSTUPAK ZA STICANJE OPEN BADGE (*OVORENOG BEDŽA*)

Projekt: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Poveznica putem web stranice: https://www.cl-bvet.eu/education-and-training/

Za dobijanje *Open Badge* potrebno je da polaznik uspješno završi program obuke i ispuni sljedeće uslove:

- uspješno pohađanje i završetak programa obuke;
- izrada funkcionalnog projektnog zadatka iz oblasti industrijske automatizacije korištenjem *PLC* ili sličnih sistema;
- izrada pripadajuće tehničke dokumentacije (električne i pneumatske šeme, PLC program i opis rješenja);
- priprema i izvođenje kratke prezentacije realizovanog projektnog zadatka;
- demonstracija funkcionalnosti realizovanog rješenja na opremi ili u simulacijskom okruženju;
- pozitivna ocjena projektnog zadatka, tehničke dokumentacije i prezentacije od strane komisije.

Open Badge se dodjeljuje polaznicima koji su dokazali stečene kompetencije u oblasti *PLC* programiranja, industrijske automatizacije, *HMI* vizualizacije, elektro-pneumatskog upravljanja i izrade tehničke dokumentacije kroz praktičan rad i evaluaciju.

Izbor zadatka:

1. Polaznik bira ili dobija zadati problem iz oblasti industrijske automatizacije koji uključuje primjenu *PLC* sistema.
2. Na osnovu zadatka izrađuje funkcionalno rješenje koje obuhvata *PLC* program, električnu i pneumatsku šemu te *HMI* vizualizaciju (ukoliko je predviđena zadatkom).
3. Nije dopuštena upotreba već postojećih ili ranije izrađenih rješenja.
4. Projekat mora biti samostalno izrađen i dokumentovan.
5. Završeni projektni zadatak i tehnička dokumentacija dostavljaju se putem linka navedenog u nastavku.

Predstavljanje:

1. Pripremiti kratku prezentaciju (7–10 slajdova) koja prikazuje problem, korištene komponente, PLC programsko rješenje, način rada sistema i ostvarene rezultate.
2. Prezentacija treba sadržavati fotografije, snimke ekrana ili video-zapis rada sistema.
3. Prezentaciju dostaviti putem linka navedenog u nastavku.

Rok za prijavu i predaju:

• Svi digitalni materijali (projektni zadatak i prezentacija) moraju biti dostavljeni najkasnije 10 dana prije datuma predvidjenog na Oglasnoj tabli.

Link za prijavu i predaju materijala:
https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply

Open Badge se dodeljuje polaznicima koji uspešno završe sve navedene korake i čiji projektni zadatak i prezentacija budu pozitivno ocijenjeni.

10. METODE OSIGURANJA KVALITETA

OSIGURANJE KVALITETA PROVODI SE U SKLADU S PRAVILNIKOM O SISTEMU OSIGURANJA KVALITETA KRATKIH PROGRAMA OBUKA SA MIKROKREDITIMA (*OPEN BADGE*).

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