



Short training program Microcredentials (Open Badge)

CNC technologies in educational process

The training program was prepared by

Innovation and entrepreneurship center Tehnopolis

Experts:

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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)





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.

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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.

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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.

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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.

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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

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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.



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.

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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

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.

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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.



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

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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

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

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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.

Open Badge

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**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

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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>



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

