Erasmus+

**KA2 MICA 1.9.2015 to 31.8.2018**

**Output 1: Shared curricula**

**#ErasmusPlusMICA**

tredu
TAMPEREEN SEUDUN AMMATTIOPISTO

laietania
manresa

IM. KRZYSZTOFA KAMILA BACZYŃSKIEGO
LCKZiU

CENFIM

SPŠT

mes
Max-Eyth-Schule Stuttgart

**ABSTRACT**

MICA (Mechanical Industrial Collaborative Assignments) will be Erasmus+ KA2 strategic partnership project on vocational education to further develop and implement technical workshops connected with CNC, automation, assembling, welding and flexible manufacturing systems learning tasks. These international student workshops (2 weeks) will be realized according the modern industrial company needs and partly in the company premises.

The main aim of MICA is to enable VET transfer and learning cooperation with schools and companies. This also increases technical and intercultural soft skills concerning technical VET on industrial trades in Europe. The main aim is to foster and further develop VET organizations and companies cooperation and enable sustainable work methods according each curricula through international technical workshops in companies. All this happens through student and teacher workshops linked with and virtual cooperation with new pedagogical approach.

Key words: cooperation, skills, workshops, pedagogical approach

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# 1 INTRODUCTION

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## 1.1 How the two weeks are planned

# 2 FIRST WORKSHOP IN TAMPERE VOCATIONAL COLLEGE

The idea of Tampere workshop is to teach separate skills and joint those skills in one entity. This is done by teach robotics and CNC- machining in school and use those skills in FMS-course, which is taking part in company called Fastems.

## 2.1 Skills requirements and curricula of Robotics

The student shall know how to operate and control industrial robots. Course is based on exercises done by student group of four people from four different schools and country.

Required skills to apply:

- Basic technical skills

After this course student:

- know the fundamentals of how to use robotics as part of an automation system
- is familiar with the structure and operation space of the most common robot models
- know how to use various co-ordinate systems and positioning techniques, as needed
- is familiar with robot online (using hand controller) programming principles and is able to conduct simple robot programming tasks
- is familiar with robot offline (using robot software) programming principles and is able to conduct simple robot programming tasks
- is able to connect related automation devices to a robot and incorporate them program-wise into the operation of the robot
- is able to take into consideration the shielding and protective structures required by the automatic operational environment in his/her work.

- be able to run a test on their own program and even use it in a production run

(OPH, www-page, 2018)

This part includes:

- Lessons fundamentals about robotics

Programexercises with following robots

- ABB
- Mitsubishi

## 2.2 Skills requirements and curricula of CNC- Machining

Required skills to apply:

- be able to read and interpret mechanical drawing projections, cross-sections, dimensions and their related tolerances and surface markings
- know the fundamentals of CAD/CAM
- know how to operate a CNC machining tool safely
- know the fundamentals of CNC technology
- know the common machining tools
- is familiar with the common M-commands, like M3, M8, M9 and M30

After this course student is familiar with following commands and process

- Cycl def
- Cycl call
- Tool call
- LBL SET
- LBL CALL
- Cycl def 7
- Cycl def 7 reset

- Plane spatial, stay, move, turn
- Plane reset
- L, RND, CHF, CC+C, CR, CT

This part includes

- Lessons
- Program exercises
- Machining with 5 axis machining center

## 2.3 Skills requirements and curricula of FMS

The student or candidate shall know how to produce pieces using a flexible manufacturing system (FMS), which includes an NC machine. They shall have a command of and know to use an FMS system and robot. Using the system, they shall also be able to cost-effectively produce complex pieces in accordance with industrial dimension and quality requirements.

Required skills to apply:

- Robotics course
- CNC-Machining course

After this course student:

- know the operating tasks of a flexible manufacturing system (FMS) needed for work
- know basic system maintenance tasks
- be able to load and unload work pieces
- be familiar with the tool system and tool installation
- have a command of system programming and program management
- know how to make bit settings as well as specify tool correction data and enter it in the machining tools
- know how to restore the system from a possible malfunction
- have a command of system material management

- know how to program the robot for changing a piece
- know how to use shelf lifts
- be familiar with NC programming, which is done as CAM programming using a CAD drawing
- know how to choose the bits necessary for manufacturing
- using mechanical drawings, be able to produce a piece using FMS or a production cell

This part includes:

- Lessons and learning tasks in Fastems FMS learning environment

# 3 SECOND WORKSHOP IN LUBELSKIE CENTRUM KSZTALCENIA ZAWODOWEGO I USTAWICZNEGO

## 3.1 Skills requirements and curricula of CAD/CAM design and manufacture

Required skills to apply:

- Basic technical skills

After this course student:

- can make dimension typical machine elements
- can read working drawings and assembly drawings
- know how create orthagonal projections in engineering drawings following Method E (or First Angle Projection)
- know how create sections and revolved sections of machine elements
- know how use technical standards to dimension diameters, radiuses, arches, angles, rakes, tapers, threads and joints on engineering drawings
- know how use rules for creating toleranced dimensions, fit, shape/geometrical and positional tolerances on engineering drawings
- know how use rules for determining of surface roughness and surface lay pattern, heat treatment and termochemical treatment on engineering drawings
- know how use computer software aiding creation of engineering drawings

### 3.2 Skills requirements and curricula of CNC –lathe, - cutting and milling cutter

Short description

Required skills to apply:

- The student or candidate shall know how to use a 2-axis CNC machining tool.
- They shall have a command of CNC programming and be familiar with bits and bit materials
- Cutting fluids and raw materials to the extent that
- Using mechanical drawings, they are able to produce complex pieces in accordance with industrial dimension and quality requirements.

After this course student:

- know how to select cutting tools for roughing and finishing holes
- know how to choose a clamp type that best suits a workpiece
- know how to program a CNC machine to machine a workpiece
- know how to use machining cycles according to the manufacturing process
- know how to select tool holders for proper fastening of the cutting tools
- know how to carry out stright turning operations on a workpiece
- know how to carry out facing operations on a workpiece
- know how to drill holes using turning lathe
- know how to carry out slab-milling operations
- know how to mill holes
- know how to carry out turning operations
- know how to carry out milling operations
- be able to read and interpret mechanical drawing projections, cross-sections, dimensions and their related tolerances and surface markings
- know the fundamentals of CAD/CAM

- know how to operate a CNC machining tool safely
- know how to choose materials and working clearances according to a drawing
- be able to plan the order of different work phases and their required mountings
- be able to use various measurement instruments as well as inspect and adjust them before use
- know how to run the machine axes to the reference points and check machine function
- know the more common error notifications issued by the machine
- be able to mount the work piece so that its form and measurement precision and its surface quality are preserved in accordance with the drawing
- know how to use hoisting equipment correctly
- be able to look for and set the zero point and, if necessary, make corrections to it
- know how to enter a finished program in the machining tool and edit it
- know how to write common programs and use tool nose radius compensation and work cycles in them
- be able to test the program before milling an actual piece
- know how to document the setting
- be able to finish and measure the piece they produce and, if necessary, make corrections to achieve a piece that meets mechanical engineering quality and precision requirement

# 4 THIRD WORKSHOP IN INSTITUT LACETÁNIA

## 4.1 Skills requirements and curricula of Automation

Required skills to apply:

- Interpretation of Electric schemes.
- Mechanical installation of PLC in the electrical panel.
- Use of the TIA Portal (v13) environment for the PLC program edit, and HMI configuration.
- Start up and verification of the I/O connection.
- Program design of the station, in KOP language (IEC 61131-3), based in grafcet diagram.
- Design of the HMI simulated device with WinCC integrated software in TIA Portal.
- Start up general of the station, and operation check.

After this course student:

- know the structure and operating principle for a distributed control system
- know the principles of the more commonly used data communications solutions for systems
- know the principles of data communications and wireless data transmission
- be able to install equipment in control cabinets and equipment/devices being controlled
- be able to install cables and wires in cable routers and take potential sources of interference into consideration
- know how to earth cables and equipment
- know how to install sensors and actuators in different control units

- be able to use measurement instruments to ensure proper cabling
- use software, troubleshoot and monitor functions
- be able to identify various pneumatic valves and cylinders as well as understand
- know how to make adjustments to pneumatic system functions and locate faults in the system
- be able to mechanically install actuator control devices and sensors
- be able to cable and make control system connections
- know how to use programmable logic in controlling systems
- make mechanical installations and perform power supply and control system
- cabling and connections
- implement a control program for a single piece of automation equipment and transfer it to a control system
- be able to start a control system administrative program (logic program)
- know how to set necessary parameters for the program and make other changes affecting equipment operation
- be able to use tools for the installation of automation equipment
- know how to use measurement instruments needed for measuring condition
- know how to use logic program diagnostic tools to check equipment performance

## 4.2 Skills requirements and curricula of CAD/CAM

The Workshops that will be carried out at CFP are intended to give the student a general vision of the whole component design, programming, production and verification processes in a CAD-CAM environment. The students will work on the modification of a pre-existent part and be able to follow up the operations conducting to the accomplishment of the new specifications.

Required skills to apply:

- Knowing the different machining processes and their optimal sequence in components production
- be able to read and interpret mechanical drawing projections, cross-sections, dimensions and their related tolerances and surface markings
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After this course student:

- know the procedures for the automatic generation of CNC programs with CAM software.
- can analyze the creation process of a numeric control program in a CAM system
- know how to post process the information for generating ISO codes.
- know how qualify in data dump to control desk, prior to machining.
- know the fundamentals of CAD/CAM
- know how to operate a CNC machining tool safely
- know how to choose materials and working clearances according to a drawing
- be able to plan the order of different work phases and their required mountings
- be able to use various measurement instruments as well as inspect and adjust them before use

- know how to run the machine axes to the reference points and check machine function
- know the more common error notifications issued by the machine
- be able to mount the work piece so that its form and measurement precision and its surface quality are preserved in accordance with the drawing
- know how to use hoisting equipment correctly
- be able to look for and set the zero point and, if necessary, make corrections to it
- know how to enter a finished program in the machining tool and edit it
- know how to write common programs and use tool nose radius compensation and work cycles in them
- be able to test the program before milling an actual piece
- know how to document the setting
- be able to finish and measure the piece they produce and, if necessary, make corrections to achieve a piece that meets mechanical engineering quality and precision requirement
- know how to use a 3D CAD/CAM program
- be able to model a 3D piece based on documents
- know how to use drawing levels
- be able to make toolpaths for 2D and 3D forms
- know how to move a modelled piece to the zero point
- know how to use typical data transfer formats
- knows how to use a post-processor and understands its importance
- be able to choose the necessary elements for the toolpath
- limit the toolpath to the desired area
- know how to use the tool library and add new tools to it
- know how to choose the right tool for the intended use
- be able to set the correct shaving values and shaving thicknesses according to material
- be able to choose the right machining technique
- know how to use working clearances appropriate

- know breaking and finishing phases
- know how to check the toolpath before moving it to the machining tool
- be able to correct flaws in the toolpath
- be able to move the toolpath to the machining tool and machine a piece
- take machining tool characteristics into consideration when making toolpaths

# 5 FOURTH WORKSHOP IN MAX-EYTH-SCHULE STUTTGART

## 5.1 Skills requirements and curricula of PLC Programing

Required skills to apply:

- Basic technical skills

After this course student:

- know the basic principle about machinery safety
- know the principles of the more commonly used data communications solutions for systems
- know the principles of data communications and wireless data transmission
- be able to install equipment in control cabinets and equipment/devices being controlled
- know how to install sensors and actuators in different control units
- be able to use measurement instruments to ensure proper cabling
- use software, troubleshoot and monitor functions
- be able to identify various pneumatic valves and cylinders as well as understand
- know how to make adjustments to pneumatic system functions and locate faults in the system
- be able to mechanically install actuator control devices and sensors
- be able to cable and make control system connections
- know how to use programmable logic in controlling systems
- make mechanical installations and perform power supply and control system cabling and connections
- implement a control program for a single piece of automation equipment and transfer it to a control system
- be able to start a control system administrative program (logic program)

- know how to set necessary parameters for the program and make other changes affecting equipment operation
- be able to use tools for the installation of automation equipment
- know how to use logic program diagnostic tools to check equipment performance

### 5.2 Skills requirements and curricula of Robotics

Required skills to apply:

- Basic technical skills

After this course student:

- know the fundamentals of how to use robotics as part of an automation system
- is familiar with the structure and operation space of the most common robot models
- know how to use various co-ordinate systems and positioning techniques, as needed
- is familiar with robot online (using hand controller) programming principles and is able to conduct simple robot programming tasks
- is familiar with robot offline (using robot software) programming principles and is able to conduct simple robot programming tasks
- is able to connect related automation devices to a robot and incorporate them program-wise into the operation of the robot
- is able to take into consideration the shielding and protective structures required by the automatic operational environment in his/her work.
- be able to run a test on their own program and even use it in a production run

### 5.3 Skills requirements and curricula of Rapid Prototyping

Required skills to apply:

- Basic technical skills

After this course student:

- be able to model a 3D piece based on documents
- print model with 3d printer
- know fundamentals about 3d printing
- know fundamentals about rapid prototyping

# 6 FIFTH WORKSHOP IN CENTRO DE FORMACÃO PROFISSIONAL DA INDUÚSTRIA METALÚRGICA E METALOMECÂNICA

## 6.1 Skills requirements and curricula of CNC Technology

Required skills to apply:

- Basic technical skills

After this course student:

- know and understand what a Process Plan is
- know and understand what a Tool Data Sheet is
- know and understand the fundamentals of cutting technology
- know and understand the basic techniques for measuring cutting tools
- interpreter
- can fill the Process Plan Data Sheet
- interpreter the Tool Data Sheet
- operate the CNC Milling for warm up & basic settings
- prepare & Measure cutting tools using basic techniques
- be able to read and interpret mechanical drawing projections, cross-sections, dimensions and their related tolerances and surface markings
- know the fundamentals of CAD/CAM
- know how to operate a CNC machining tool safely
- know how to choose materials and working clearances according to a drawing
- be able to plan the order of different work phases and their required mountings
- be able to use various measurement instruments as well as inspect and adjust them before use
- know how to run the machine axes to the reference points and check machine function

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- be able to test the program before milling an actual piece
- know how to document the setting
- be able to finish and measure the piece they produce and, if necessary, make corrections to achieve a piece that meets mechanical engineering quality and precision requirement

## 6.2 Skills requirements and curricula of 5 –axis machining

Required skills to apply:

- Basic technical skills

After this course student:

- know tilting Fundamentals
    - Axis arrangement as per ISO
    - 3 axis machining / 3+2-axis machining/ 5 axes simultaneously
    - 5-axis milling machines –Design types
- know how to tilting with one spatial angle
    - Spatial angles
    - Programming with PLANE SPATIAL
- know fundamentals about datum shift
- know how program structure works
- know how to optimize the tilting program
    - Safe positioning with M91

    - Subprogramming
    - Program header
    - Summary
- Know how tilting with multiple spatial angles
    - Preferred tilting sequence C-B-A
    - Tilting sequence A-B-C / C-B-A

This part includes following case Study

- Programming
- Machining

# 7 SIXTH WORKSHOP IN STŘEDNÍ PRŮMYSLOVÁ ŠKOLA TŘEBÍČ

## 7.1 Skills requirements and curricula of PLC programming

Required skills to apply:

- Basic technical skills

After this course student:

- know the structure and operating principle for a distributed control system
- know the principles of the more commonly used data communications solutions for systems
- know the principles of data communications and wireless data transmission
- be able to install equipment in control cabinets and equipment/devices being controlled
- be able to install cables and wires in cable routers and take potential sources of interference into consideration
- know how to earth cables and equipment
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- Basic technical skills

After this course student:

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# 8 COMMON LEARNING OUTCOMES FOR ALL THE WORKSHOPS

## 8.1 Foreign language

Objectives

Student

- communicates and acts in interactive situations in a way that he/she can work
- in his/her profession, contribute to working life, be an active citizen and pursue further studies
- possesses the language skills required in the vocational field
- Knows how to act in a multicultural and multilingual environment.

## 8.2 Cultural knowledge

Objectives

Student

- gets along with people representing different cultures
- knows how to greet and receive visitors and talk to them
- is able to observe the limits of appropriateness in his/her activities, the different roles of men and women, the instructions on dressing and behavior as well as the unwritten rules and procedures
- recognizes cultural differences in workplace behavior, hierarchy and in work related public relations and behaves accordingly in normal work situations
- describes his/her country's common cultural features to representatives of other cultures: such as essential history, sights, arts, sports achievements and entertainment and also his/her craftsmanship, work methods and innovations

- recognizes his/her special features in other countries in his/her vocational field

### 8.3 Multicultural teamwork skills

After this course student:

- can solve problems part of multicultural team
- can adapt and work in part of multicultural team

**Sources**

Finnish national agency of education (OPH). Read 8.3.2018. http://www.oph.fi/download/140429_vocational_qualification_in_metal-work_and_machinery_2010.pdf