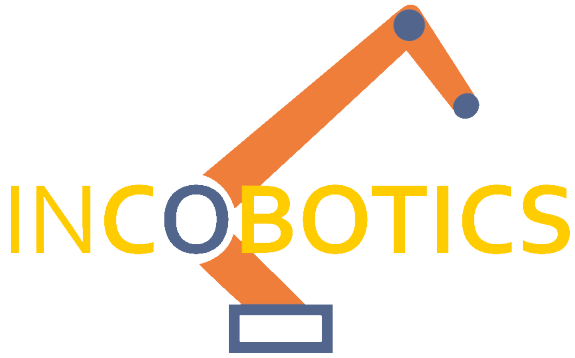

INCOBOTICS 5.0 – Ready for Industry 5.0

Project number: 2019-1-ES01-KA201-064454

ECTS Accreditation Gudie

I/O2 – Best Practice Guide

February 2021

Author: IDEC

Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Revision History [not for public deliverables]

Date	Version	Author	Changes
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Project Details:

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Start Date: 01-10-2019
End Date: 30-09-2021
Coordinator: POLITEKNIKA IKASTEGIA TXORIERRI S.COOP

Table of Contents

Table of Figures

1. What is an ECTS?

Introduction

The objective of this guide is to provide the necessary information and tools for applying the ECTS system of credits allocation to the courses and training implemented in the context of the INCOBOTICS 5.0 project. Here, the definition of this common framework for credit recognition adopted in the European Union is going to presented. In order to fully grasp the importance of the ECTS tool, this Guide will also include an introduction to the ECVET scheme, both closely linked for the recognition and validation of valuable learning experiences completed in different European countries. Such introduction will go through the main components of ECVET, highlighting the links with the ECTS when these are relevant.

Definition of ECTS

The European Credit Transfer System, mostly known as ECTS, is a framework system for the accumulation and transfer of credits. The principle of transparency permeates all the phases of the education process: learning, teaching and assessment. It has been developed in order to facilitate the planning, delivery and evaluation of learning and study programmes: its application greatly support and facilitate the mobility of students and learners across the European Union thanks to a common credit framework allowing for the smooth recognition of exams, courses and other form of learning experiences in the rest of the Union. It is one of the cornerstones of the European Higher Education Area.

The main components allowing the ECTS to be applied are the Learning Outcomes and Workload. Both are associated to the course to which an amount of ECTS will be allocated. Both concepts are also very relevant for ECVET, which is going to be presented later on. The first one is defined as follows: what the individual know, understands and is able to do on completion of a learning process; the second one instead regards the estimation of the time the individual typically needs to complete all learning activities.

2. How do they work?

Regarding the application of the ECTS model, crucial importance is recognised to the workload associated to the learning outcome. In fact, the central ratio in the allocation of the credits is the following one:

Full-time workload of an academic year: ***60 credits***

It ranges between ***1500-1800 hours*** *for year*

Given these parameters, it is possible to define **1 credit as 25-30 hours of work**.

Once this aspect is established, other operation tools are associations with the ECTS. These are the following:

- *Allocation*: the process of assigning a number of credits to qualifications, degree programmes or single educational components;
- *Awarding*: the act of formally granting students and other learners the credits that are assigned to the qualification and/or its components if they achieve the defined learning outcomes;
- *Accumulation*: process of collecting credits awarded for achieving the learning outcomes of educational components in formal contexts and for other learning activities carried out in informal and non-formal contexts.
- *Transfer*: the process of having credits awarded in one context (programme, institution) recognised in another formal context for the purpose of obtaining a qualification.

The last point is particularly relevant if framed in the context also of ECVET, which both works for the harmonization of learning experiences in the European Union and thus facilitating the mobility of many learners regardless of their age, context and qualification they are trying to achieve.

How does the recognition of the credits take place? At the institution level it is recognised that the learning outcomes achieved in another context satisfy the requirements of the programmes the offer, unless it can be proved otherwise. To support this process, a specific set of standardised documents are usually employed, such as the Learning Agreement, the Transcript of Records etc.

3. Introduction to ECVET

The European Credit System for Vocational Education and Training (ECVET) is a technical framework ensuring the smooth transfer, recognition and accumulation of learning outcomes achieved in different countries of the European Union. This process envisages that the students obtain a qualification after the completion and achievement of all the learning outcomes necessary. The general objective of this framework is to make the experience of learning mobility more appealing and overall simpler in the context of lifelong learning.

The framework was established with a Recommendation adopted on June 18th, 2009 by the European Parliament and the Council of the European Union. The document invited European Member States to make the necessary changes in order to create a compatible educational framework allowing the mobility programs to take place in a way that allows students to continue working on their learning process.

In promoting close cooperation between the States regarding their respective educational system, ECVET works for ensuring the transparency of the qualifications granted thanks to an EU-level approach to the recognition of learning outcomes making up such certifications. On the other hand, it provides certain technical tools that are standardised and thus easily shareable among the countries in order to simplify the process of learning outcomes validation.

The main principles and tools of ECVET are summarised here before more details and provided further below:

- Learning Outcomes
- Units of Learning Outcomes
- ECVET Points
- Credit

- Learning Agreement and Memorandum of Understanding (MoU)

4. ECVET Units

Qualifications as intended by the ECVET recommendation and then further elaborated by the Working Group in 2017 *should be composed of clearly defined groups of learning outcomes*[1]. The same LOs can be part of different qualifications, which makes the ECVET-based approach to the achievement of different certifications a very flexible tools for setting up innovative learning pathways for trainees.

LOs are going to be closely looked at in the following section. However, it is important to highlight here the connection between the ECVET framework and its main tools. LOs represent the goal of the transnational mobility to which the ECVET principles apply. By recognising and validating the LOs, the trainees can work on achieving a qualification in a transnational way efficiently, over a certain period of time. To this end, the ECTS as presented the previous sections are compatible with VET qualifications.

ECVET points are assigned to each learning outcomes in a qualification and represent a numerical value for the weight of said LO. They can be assigned also to whole units or qualifications. Similarly to ECTS, 60 ECVET points are allocated to a full year of formal VET, which is taken as a reference.

5. Learning Outcomes

A Learning Outcome, as also introduced for the ECTS, is a coherent set of knowledge, skills and competences which can be assessed and evaluated. It describes the result of a learning process and it represents the basic unit for the achievement of a qualification. Upon completion, the learner masters the three components of which the outcome is composed of. The focus is on what one is able to do (learner's perspective) once they have successfully completed all the units composing the once the LO rather than on what is being taught (educator's perspective).

The achievement of a LO entails the recognition of a certain number of ECVET points, an expression in number of the knowledge associated to the unit. Several units make up each qualification: the learner must accumulate all the required units in order to achieve the desired qualification. Such units can be obtained in a country and then recognised and validated in another one thanks to the application of ECVET principles and tools.

Each LO should be described in legible and understandable terms by referring to the knowledge, skills and competences contained in them. The Recommendation on the European Qualifications Framework – EQF provide the necessary definition for the components of the LOs:

[1] ECVET, *Principles for supporting flexible VET pathways*. Accessible here: https://www.ecvet-secretariat.eu/en/principles-supporting-flexible-vet-pathways Last accessed: February 22nd, 2021 11:21 AM EET.

***Knowledge**:* the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual;

***Skills**:* the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments);

***Competences**:* the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy.

The EQF is also used as a reference for defining the levels of the qualification, along with the specific national framework of reference.

6. Defining a Learning Outcome

The Bloom taxonomy was firstly developed in 1956 and it is a useful tool for the drafting of learning outcomes. It consists in a hierarchy of increasingly complex processes to be taught and grasped by the students.

1. Cognitive domain

In 1956, it was proposed by Bloom that "knowing" is composed of six successive levels arranged in a hierarchy. It relates to the *knowledge* component of LOs.

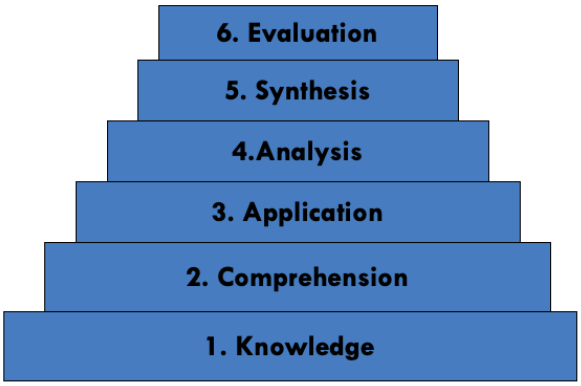


Figure 1 - Cognitive Domain Pyramid

- ***Knowledge***: the ability to remember facts without necessarily understanding them
- ***Comprehension***: the ability to understand and interpret learned information
- ***Application***: the ability to use learned material in new situations,
- ***Analysis***: the ability to break down information into its components
- ***Synthesis***: the ability to put parts together
- ***Evaluation***: the ability to judge value of material for a given purpose

Some of the words which helps defining the concept of "cognitive domain" are the following:

Knowledge: *Arrange, collect, define, describe, duplicate, enumerate, examine, find, identify etc.*

Comprehension: *Associate, change, clarify, classify, construct, contrast, convert, decode, defend, describe etc.*

Application: *Apply, assess, calculate, change, choose, complete, compute, construct, demonstrate, develop, discover etc.*

Analysis: *Analyse, appraise, arrange, break down, calculate, categorise, classify, compare, connect, contrast, criticise etc.*

Synthesis: *Argue, arrange, assemble, categorise, collect, combine, compile, compose, construct, create, design etc.*

Evaluation: *Appraise, ascertain, argue, assess, attach, choose, compare, conclude, contrast, convince etc.*

2. Emotive skills domain

This second domain relates to value issues and attitudes. It is linked to the competence aspect of LO. These are the main components:

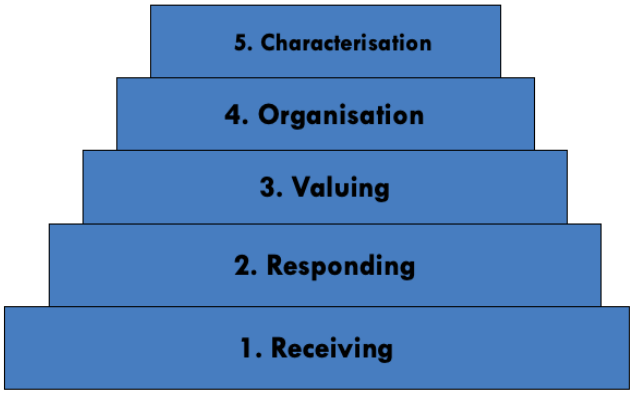


Figure 2 - Emotive skills domain pyramid

- ***Receiving***: the willingness to receive information
- ***Responding***: the active participation in own learning

- *Valuing*: the commitment to a value
- *Organisation*: comparing, relating, synthesising values
- *Characterisation*: the integration of beliefs, ideas and attitudes

Some words which might help clarify the nature of the emotive skills are:

Appreciate, accept, assist, attempt, challenge, complete, defend, discuss, dispute, embrace, follow, hold, integrate, join, share, judge, praise, question, relate, share, support, synthesise, value.

3. Psychomotor domain

It involves the coordination of brain and muscular activity. Active verbs for this domain are:

bend, grasp, handle, operate, perform, reach, relax, shorten, stretch, differentiate (by touch), perform (skilfully).

4. Writing a Learning Outcome

In order to clearly define the LO, the Bloom taxonomy provides us with the ***active*** verbs listed so far in order to better define the knowledge, skills and competences that the learning programme will offer. A crucial aspect is to have clear the idea of the outcome to be achieved, or the desired results, of the LO. Some examples might be the occupational profile that we are trying to define, its competences and the sector studies. During this phase, the evaluation and assessment component must be already taken into consideration (this Guide presents it a bit further, in the following section).

Given the learners-oriented approach of the ECTS and ECVET frameworks, the learning component must be defined from the point of view of the learners. For this reason, we talk of learning outcomes rather than learning objectives (the intention of the teachers regarding the content to be presented).

Thus, the components to be defined are knowledge (according to the cognitive domain), skills (according to the psychomotor domain) and competences (according to the emotional skills domain). A very common tip that helps summarise all the main aspects to be taken into consideration when drafting LOs are the following, whose acronym is *SMART*:

- *Student-centred;*
- *Measurable;*
- *Action-oriented;*
- *Results-driven;*
- *Tailored to specific programs*;

Other important suggestions that are worth keeping in mind are to use a single verb's tense (either future or present), avoid vague expression and make clear deadlines (at the end of the training, the trainee will be able to...). Overall, a module should revolve around 5-7 learning outcomes.

7. Evaluation and Assessment

The assessment of each LO should be independent from the rest of the qualification in order to ensure the necessary flexibility for both the achievement of the certification and the recognition of the credits abroad. The goal of the evaluation is that of verifying that the components of the training have been received and that the users is now fully endowed with the knowledge, skills and competences associated to said LO. Different methods of assessment can be put in place according to the necessities and specificities of each Outcome.

- ⇒ ***Formative assessment***: it provides feedback to learners to adjust learning activities and it is integrated into the learning process;
- ⇒ ***Summative assessment***: it takes place at the end of a programme or module by assessing only a sample of the training, resulting in a mark or a grade for the learner.

A combination of both can be also designed. In any case, it is important that this aspect is holistically approached so to define everything in the inception phase of the Learning Outcome. In practice, the tools available for carrying out the assessment are the following:

- ⇒ ***Written***: tests, examination, assignments;
- ⇒ ***Practical***: skills testing, lab/workshop practice;
- ⇒ ***Oral***: interviews, various formats;
- ⇒ ***Aural***: listening tests;
- ⇒ ***Project work***: individual/group; research/design;
- ⇒ ***Field work:*** data collection and reporting;
- ⇒ ***Competence***: threshold standards;
- ⇒ ***Portfolio***: combination of techniques.

A plan can be drafted in order to combine the different aspects of the evaluation and link them with one or more LOs in the same Unit (which is going to be presented later on).

	Assessment Task 1 e.g. Written Exam	Assessment Task 2 e.g. Project	Assessment Task 3 e.g. Presentation	Assessment Task 4 e.g. Lab work
L.O. 1				
L.O. 2				
L.O. 3				

Figure 3 - Assessment Plan

It is important that the evaluation and grading system is fully understood by the learners. To this end, the drafting of a rubric stating the criteria and guidelines of the examination.

L.O.	Assessment Criteria				
	Grade 1	Grade 2:1	Grade 2:2	Pass	Fail

Upon completing this L.O., the learner is able to: [summary]	Outstanding use of literature showing excellent ability to synthesize evidence in analytical way to formulate clear conclusions.	Very good use of literature showing high ability to synthesise evidence in analytical way to formulate clear conclusions.	Good use of literature showing good ability to synthesise evidence in analytical way to formulate clear conclusions	Limited use of literature showing fair ability to synthesise evidence to formulate conclusions.	Poor use of literature showing lack of ability to synthesise evidence to formulate conclusions

Figure 4 - Assessment and Evaluation Rubric (ex.)

This is the example of a LO matrix, explicating all the information for the definition, training/learning activities and assessment.

Learning Outcomes	Teaching and Learning Activities	Assessment
Cognitive (Demonstrate: Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation) *Affective* (Integration of beliefs, ideas and attitudes) *Psychomotor* (Acquisition of physical skills)	Lectures Tutorials Discussions Laboratory work Clinical work Group work Seminar Peer group presentation etc.	• End of module exam. • Multiple choice tests. • Essays. • Reports on lab work and research project. • Interviews/viva. • Practical assessment. • Poster display. • Fieldwork. • Clinical examination. • Presentation. • Portfolio. • Performance. • Project work. • Production of artefact etc.

Figure 5 - Learning Outcome's matrix

7. Grouping Learning Outcomes into Units

A group of LOs can be identified and coherently sorted together in order to define a unit. A unit can be considered a component of a larger qualification. These LOs helps defining and building the overall set of knowledge, skills and competences of each unit and in turn of each qualification. They can be grouped together according to the set of knowledge they want to deliver, to the set of occupational skills. Usually, in case of VET qualifications the units focus on the specific activities an employee has to carry out in the workplace. In any case, the rules and procedures are established by competent institutions and according

to the national of regional rules. Finally, the expected learning outcomes associated to a unit can be achieved regardless of where or how these have been achieved.

Units usually follow a standard structure which can be represented as follows:

- *Title of the Unit*
- *Title of the qualification (or qualifications) to which the unit relates*
- *Credit points associated and reference level according to EQF and NQF*
- *Short description (objectives)*
- *Learning outcomes*
- *Structure (learning methodology)*
- *Assessment*
- *ECVET points associated with the unit*
- *Learning content, bibliography, resources*
- *The validity in time if applicable*

Deductively, we can start from the qualification in trying to define the objectives and how the units can fit all together. Then we move to the definition of the learning outcomes (as introduced in this guide before): in this phase it is crucial to have clear in mind the objectives, the learning methodology and learning outcomes of the overall process, as well as the assessment approach. Once all these aspects are clear, it will be possible to allocate a certain number of ECTS to the unit according to the proportion presented before:

1 credit = 25-30 hours of workload

If the learning methodology to be applied do not respect the usual guidelines of a formal learning approach, and instead it tries to explore other forms of non-formal learning methodology, the calculation of the workload and thus of the ECTS allocated is usually arbitrary.

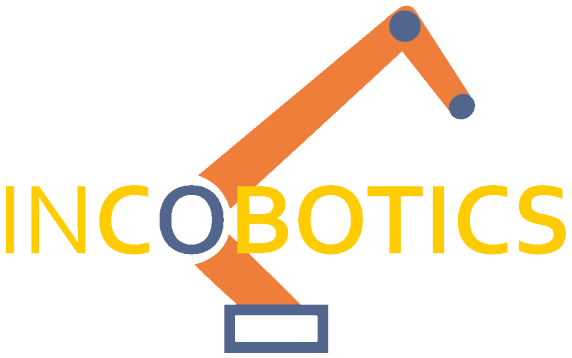
Title of the Unit
Qualification it refers to
EQF Level
Unit 1 - Description
Duration (in hours)

N° of credits			
Learning outcomes			
Knowledge	Skills	Competences	Assessment
…	…	…	…
…	…	…	…
Etc.	Etc.	Etc.	Etc.

Figure 6 - Unit (ex.)

8. Annexes

8.1 General Template



INCOBOTICS 5.0 – Ready for Industry 5.0

Project number: 2019-1-ES01-KA201-064454

MODULE TEMPLATE

[JANUARY] [2021]

Co-funded by the Erasmus+ Programme of the European Union

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Revision History [not for public deliverables]

Date	Version	Author	Changes
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Current version: 1.0

Project Details:

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Acronym: INCOBOTICS
Start Date: 01-10-2019
End Date: 30-09-2021
Coordinator: POLITEKNIKA IKASTEGIA TXORIERRI S.COOP

Co-funded by the Erasmus+ Programme of the European Union

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Contents

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Title: INCOBOTICS

Qualification:

Level:

Semester:

ECTS: 4

(corresponding to 60-80 SWL hours)

Short description – objectives

Learn to program different brands of cobots and artificial vision systems, through different types of movements, basic and advanced instructions, as well as the use and management of digital inputs and outputs.

Learning outcomes (KSC)

On successful completion of this module, students should be able to:

LO1: Comprehend the CO-BOTS major brands available on the market

LO2: Configure Cobot systems, selecting and connecting the component elements.

LO3: Program Cobot systems, using programming and data processing techniques.

LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.

LO5: Configure Artificial Vision systems, selecting and connecting the component elements.

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LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.

Detailed scheme of KSC

On successful completion of this module, students should be able to:

LO	Knowledge	Skills	Competences
LO1: Comprehend the CO-BOTS major brands available on the market.	Identify the different brands and types of collaborative robots. Identify and differentiate characteristics.	choose the appropriate type of robot. differentiate robots from cobots	Apply collaborative robot technologies in several industrial processes. Operate with different cobot brands. Analyze risk of cobots use and determine the correct safety configuration. Propose different solution to manage a industrial process that involve a collaborative robot. Analyze automatic cycles and find the better solution to compute the program. Predict issues, examine several solutions and experiment ways to perform the result. Argue and defend the chosen solution for the challenge. Collect information in order to solve a problem.
LO2: Configure Cobot systems, selecting and connecting the component elements.	Define the parts of a robot system. Identify external component in a robot system.	Recognize all the hardware parts of a robot system and relate their function. Interpret the connection diagram and the mounting instructions. Choose correct external tools and relate it with its use. Interpret external components/tool diagrams and integrate them in the system.	
LO3: Program Cobot systems, using programming and data processing techniques.	Identify the use of different types of manual movements. Recognize the parts of a robot cycle and relate them in the correct use.	Examine the available manual movement modes of a robot. Relate the right manual mode with different situations. Complete manual robot movement in all	

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	Examine an automatic process and define the related robot program.	the available modalities Compare all the available movement functions and associate them with their use. Use flow control functions to manage a cycle. Use external input and output signals. Develop programs with known functions.	Organise time and tasks to solve the problem. Resolve the incoming issues. Validate the solutions by simulation and tests. Supervise different tasks to solve the challenges. Have a responsibility about different tasks into the team.
LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.	Define robot working area and relate the right safety regulation. Examine a robot cycle, find issues and solve them.	Choose the allowed/forbidden work areas and compute them in the robot system. Analyze the use of the robot and find the correct safety configuration. Test a robot cycle in manual or automatic mode. Examine issues, find a solution and modify the program in the right way.	
LO5: Configure Artificial Vision systems, selecting and connecting the component elements.	Define the general characteristics of artificial vision systems. Identify camera's features.	Connect AV systems with cobot Calibrate AV systems	

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	Identify environmental conditions in AV systems.		
LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.	Understand software features.	Train objects with their characteristics (colour, shape…) Analyze the program in each case.	

Structure

The module is structured in 3 units, while Unit 2 is further structured to subunits. Each unit/subunit has specific objectives and learning outcomes.

1. Introduction
2. Programming Cobots
   - 2.1 Programming Cobots - Manual Movements
   - 2.2 Programming Cobots - TCP Setting
   - 2.3 Programming Cobots - Working Space
   - 2.4 Programming Cobots - Point Teaching
   - 2.5 Programming Cobots - Movements 1
   - 2.6 Programming Cobots - Movements 2
   - 2.7 Programming Cobots - I/O Management
   - 2.8 Programming Cobots - Variables & Flow control
   - 2.9 Programming Cobots - Palletizing
3. Artificial Vision Systems

Learning methodology

- Seminars – presentation in the laboratory/class
- Demonstration of the robots
- Self-learning with the videos
- Experimentation with simulators
- Experimentation with robots (supervised by a teacher, safety aspects)
- Challenge- based learning (in laboratory)

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Assessment

- Standardized test (multiple choice tests for each subunit)
- Exercises with the simulators
- Exercises with the robots
- Evaluation based on challenge-based learning (only with the robots)
- Oral defense of challenge-based learning

Learning content

For each unit/subunit

- Video
- Operating mode (pdf file)
- Standardized assessment test (online)
- Activities / exercises

Five challenges (pdf files)

- Description of the challenge
- Requirements – specifications
- Learning outcomes including soft skills
- Evaluation criteria
- Timing

Bibliography – resources

TMOmron Documentation&Manuals

TMOmron TMView programming and configuration software

Stäubli manuals and documentation

Stäubli website

Universal Robot manuals and documentation

Equipment and software

3d CAD Autodesk Fusion360 and 3d Printer Creality Ender3 to create the objects used in samples and challenges

SolidWorks and simplify 3D

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SRS (Stäubli Robotics Suite)

Visor Vision Sensopart

VSDC video editor

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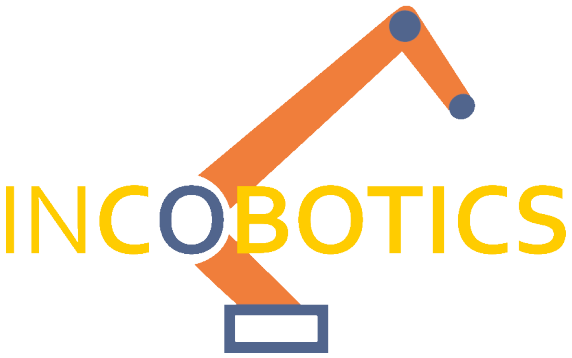
8.2 Template PIT



INCOBOTICS 5.0 – Ready for Industry 5.0

Project number: 2019-1-ES01-KA201-064454

MODULE TEMPLATE

[JANUARY] [2021]

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Contents

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Title: INCOBOTICS

Qualification: Técnico Superior en Automatización y Robótica Industrial – Higher Technician in Industrial Automation and Robotics

Level: EQF 5

Trimester: 2

ECTS: 4 ECVET

(corresponding to 40 SWL hours)

Short description – objectives

Learn to program different brands of cobots and artificial vision systems, through different types of movements, basic and advanced instructions, as well as the use and management of digital inputs and outputs.

Specific application with UR cobot and development of one of the proposed challenges

Learning outcomes (KSC)

On successful completion of this module, students should be able to:

LO1: Comprehend the CO-BOTS major brands available on the market

LO2: Configure Cobot systems, selecting and connecting the component elements.

LO3: Program Cobot systems, using programming and data processing techniques.

LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.

LO5: Configure Artificial Vision systems, selecting and connecting the component elements.

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LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.

Detailed scheme of KSC

On successful completion of this module, students should be able to:

LO	Knowledge	Skills	Competences
LO1: Comprehend the CO-BOTS major brands available on the market	Identify the different brands and types of collaborative robots Identify and differentiate characteristics	choose the appropriate type of robot differentiate robots from cobots	Apply collaborative robot technologies in several industrial processes Operate with different cobot brands
LO2: Configure Cobot systems, selecting and connecting the component elements.	Define the parts of a robot system Identify external component in a robot system	Recognize all the hardware parts of a robot system and relate their function Interpret the connection diagram and the mounting instructions Choose correct external tools and relate it with its use Interpret external components/tool diagrams and integrate them in the system	Analyze risk of cobots use and determine the correct safety configuration Propose different solution to manage a industrial process that involve a collaborative robot Analyze automatic cycles and find the better solution to compute the program Predict issues, examine several solutions and experiment ways to perform the final result Argue and defend the chosen solution for the challenge Collect information in order to solve a problem
LO3: Program Cobot systems, using programming and data processing techniques	Identify the use of different types of manual movements Recognize the parts of a robot cycle and relate them in the correct use	Examine the available manual movement modes of a robot Relate the right manual mode with different situations Complete manual robot movement in all	

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	Examine an automatic process and define the related robot program	the available modalities Compare all the available movement functions and associate them with their use Use flow control functions to manage a cycle Use external input and output signals Develop programs with known functions	Resolve the incoming issues Validate the solutions by simulation and tests Supervise different tasks to solve the challenges Have a responsibility about different tasks into the team
LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.	Define robot working area and relate the right safety regulation Examine a robot cycle, find issues and solve them	Choose the allowed/forbidden work areas and compute them in the robot system Analyze the use of the robot and find the correct safety configuration Test a robot cycle in manual or automatic mode Examine issues, find a solution and modify the program in the right way	
LO5: Configure Artificial Vision systems, selecting and connecting the component elements.	Define the general characteristics of artificial vision systems Identify camera's features	Calibrate AV systems	

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	Identify environmental conditions in AV systems		
LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.	Understand software features	Train objects with their characteristics (colour, shape…) Analyze the program in each case	

Structure

The module is structured in 3 units, while Unit 2 is further structured to subunits. Each unit/subunit has specific objectives and learning outcomes.

1. Introduction
2. Programming Cobots
   2.1 Programming Cobots - Manual Movements
   2.2 Programming Cobots - TCP Setting
   2.3 Programming Cobots - Working Space
   2.4 Programming Cobots - Point Teaching
   2.5 Programming Cobots - Movements 1
   2.6 Programming Cobots - Movements 2
   2.7 Programming Cobots - I/O Management
   2.8 Programming Cobots - Variables & Flow control
   2.9 Programming Cobots - Palletizing
3. Artificial Vision Systems

Learning methodology

- Seminars – presentation in the laboratory/class
- Demonstration of the robots
- Self-learning with the videos
- Experimentation with robots (supervised by a teacher, safety aspects)
- Challenge- based learning (in laboratory)

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Assessment

- Standardized test (multiple choice tests for each subunit)
- Exercises with the robots
- Evaluation based on challenge-based learning (only with the robots)
- Oral defense of challenge-based learning

Learning content

For each unit/subunit

- Video
- Operating mode (pdf file)
- Standardized assessment test (online)
- Activities / exercises

Five challenges (pdf files)

- Description of the challenge
- Requirements – specifications
- Learning outcomes including soft skills
- Evaluation criteria
- Timing

Bibliography – resources

Universal Robot Documentation&Manuals

Universal Robot and Robotiq programming and configuration software

Equipment and software

2 UR3

1 UR5

Robotiq and OnRobot grippers

Robotiq camera

Catia and SolidWorks software and Ultimaker 3d Printer to create the objects used in samples and challenges

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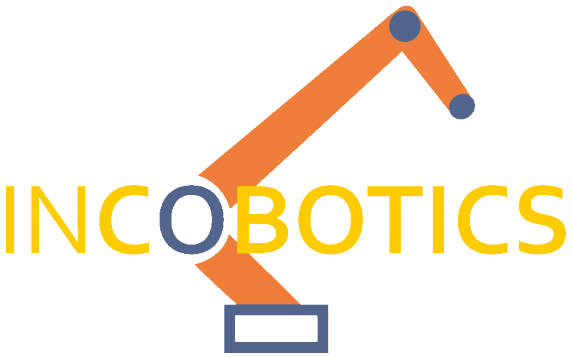
8.3 Template APRO



INCOBOTICS 5.0 – Ready for Industry 5.0

Project number: 2019-1-ES01-KA201-064454

MODULE TEMPLATE

[JANUARY] [2021]

Co-funded by the Erasmus+ Programme of the European Union

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Revision History [not for public deliverables]

Date	Version	Author	Changes
2021/1	1.0	Natassa Kazantzidou	
2021/1	1.1	Stefano Antona	Apro ITALY project

Current version: 1.0

Project Details:

Title: INCOBOTICS 5.0 – Ready for Industry 5.0
Acronym: INCOBOTICS
Start Date: 01-10-2019
End Date: 30-09-2021
Coordinator: POLITEKNIKA IKASTEGIA TXORIERRI S.COOP

Co-funded by the Erasmus+ Programme of the European Union

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Contents

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Title: INCOBOTICS

Qualification: Tecnico per l'automazione industrial – Industrial Automation Technician

Level: EQF 4

Quadrimester: 1-2

ECVET: 4

(corresponding to 40 SWL hours)

Short description – objectives

Learn to program different brands of cobots and artificial vision systems, through different types of movements, basic and advanced instructions, as well as the use and management of digital inputs and outputs.

Specific application with TMOmron cobot and development of one of the proposed challenges

Learning outcomes (KSC)

On successful completion of this module, students should be able to:

LO1: Comprehend the CO-BOTS major brands available on the market

LO2: Configure Cobot systems, selecting and connecting the component elements.

LO3: Program Cobot systems, using programming and data processing techniques.

LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.

LO5: Configure Artificial Vision systems, selecting and connecting the component elements.

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LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.

Detailed scheme of KSC

On successful completion of this module, students should be able to:

LO	Knowledge	Skills	Competences
LO1: Comprehend the CO-BOTS major brands available on the market	Identify the different brands and types of collaborative robots Identify and differentiate characteristics	choose the appropriate type of robot differentiate robots from cobots	Apply collaborative robot technologies in several industrial processes Operate with different cobot brands
LO2: Configure Cobot systems, selecting and connecting the component elements.	Define the parts of a robot system Identify external component in a robot system	Recognize all the hardware parts of a robot system and relate their function Interpret the connection diagram and the mounting instructions Choose correct external tools and relate it with its use Interpret external components/tool diagrams and integrate them in the system	Analyze risk of cobots use and determine the correct safety configuration Propose different solution to manage a industrial process that involve a collaborative robot Analyze automatic cycles and find the better solution to compute the program Predict issues, examine several solutions and experiment ways to perform the final result Argue and defend the chosen solution for the challenge Collect information in order to solve a problem
LO3: Program Cobot systems, using programming and data processing techniques	Identify the use of different types of manual movements Recognize the parts of a robot cycle and relate them in the correct use	Examine the available manual movement modes of a robot Relate the right manual mode with different situations Complete manual robot movement in all	

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	Examine an automatic process and define the related robot program	the available modalities Compare all the available movement functions and associate them with their use Use flow control functions to manage a cycle Use external input and output signals Develop programs with known functions	Resolve the incoming issues Validate the solutions by simulation and tests Supervise different tasks to solve the challenges Have a responsibility about different tasks into the team
LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.	Define robot working area and relate the right safety regulation Examine a robot cycle, find issues and solve them	Choose the allowed/forbidden work areas and compute them in the robot system Analyze the use of the robot and find the correct safety configuration Test a robot cycle in manual or automatic mode Examine issues, find a solution and modify the program in the right way	
LO5: Configure Artificial Vision systems, selecting and connecting the component elements.	Define the general characteristics of artificial vision systems Identify camera's features	Calibrate AV systems	

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	Identify environmental conditions in AV systems		
LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.	Understand software features	Train objects with their characteristics (colour, shape…) Analyze the program in each case	

Structure

The module is structured in 3 units, while Unit 2 is further structured to subunits. Each unit/subunit has specific objectives and learning outcomes.

1. Introduction
2. Programming Cobots
   2.1 Programming Cobots - Manual Movements
   2.2 Programming Cobots - TCP Setting
   2.3 Programming Cobots - Working Space
   2.4 Programming Cobots - Point Teaching
   2.5 Programming Cobots - Movements 1
   2.6 Programming Cobots - Movements 2
   2.7 Programming Cobots - I/O Management
   2.8 Programming Cobots - Variables & Flow control
   2.9 Programming Cobots - Palletizing
3. Artificial Vision Systems

Learning methodology

- Seminars – presentation in the laboratory/class
- Demonstration of the robots
- Self-learning with the videos
- Experimentation with robots (supervised by a teacher, safety aspects)
- Challenge- based learning (in laboratory)

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Assessment

- Standardized test (multiple choice tests for each subunit)
- Exercises with the robots
- Evaluation based on challenge-based learning (only with the robots)
- Oral defense of challenge-based learning

Learning content

For each unit/subunit

- Video
- Operating mode (pdf file)
- Standardized assessment test (online)
- Activities / exercises

Five challenges (pdf files)

- Description of the challenge
- Requirements – specifications
- Learning outcomes including soft skills
- Evaluation criteria
- Timing

Bibliography – resources

TMOmron Documentation&Manuals

TMOmron TMView programming and configuration software

Equipment and software

3d CAD Autodesk Fusion360 and 3d Printer Creality Ender3 to create the objects used in samples and challenges

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8.4 Template ADAMIC

INCOBOTICS 5.0 – Ready for Industry 5.0

Project number: 2019-1-ES01-KA201-064454

MODULE TEMPLATE

[JANUARY] [2021]

Co-funded by the Erasmus+ Programme of the European Union

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Revision History [not for public deliverables]

Date	Version	Author	Changes
2021/1	1.0	Natassa Kazantzidou	

Current version: 1.0

Project Details:

Title: INCOBOTICS 5.0 – Ready for Industry 5.0
Acronym: INCOBOTICS
Start Date: 01-10-2019
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Coordinator: POLITEKNIKA IKASTEGIA TXORIERRI S.COOP

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Title: INCOBOTICS

Qualification: 3rd year degree Mecatronics majoring robotics

Level: 6

Semester: 6

ECTS: 4

(corresponding to 60-80 SWL hours)

Short description – objectives

This module requires a minimum or 2-year degree with technical and also automatism knowledge.

A limit of four students per team for the challenge.

Learn to program a Stäubli cobot and artificial vision systems, through different types of movements, basic and advanced instructions, as well as the use and management of digital inputs and outputs. Knowledge, skills and competences acquired will applied during challenge.

Learning outcomes (KSC)

On successful completion of this module, students should be able to:

LO1: Comprehend the Cobots major brands available on the market

LO2: Configure Cobot systems, selecting and connecting the component elements.

LO3: Program Cobot systems, using programming and data processing techniques.

LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.

LO5: Configure Artificial Vision systems, selecting and connecting the component elements.

LO6: Program Artificial Vision systems to use with Cobot systems, using programming and data processing techniques.

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Detailed scheme of KSC

On successful completion of this module, students should be able to:

LO	Knowledge	Skills	Competences
LO1: Comprehend the CO-BOTS major brands available on the market	Identify the different brands and types of collaborative robots Identify and differentiate characteristics	choose the appropriate type of robot differentiate robots from cobots	Apply collaborative robot technologies in several industrial processes. Operate with a Stäubli cobot
LO2: Configure Cobot systems, selecting and connecting the component elements.	Define the parts of a robot system Identify external component in a robot system	Recognize all the hardware parts of a robot system and relate their function Interpret the connection diagram and the mounting instructions Choose correct external tools and relate it with its use Interpret external components/tool diagrams and integrate them in the system	Analyze risk of cobots use and determine the correct safety configuration. Propose different solution to manage a industrial process that involve a collaborative robot Analyze automatic cycles and find the better solution to compute the program Predict issues, examine several solutions and experiment ways to perform the final result Argue and defend the chosen solution for the challenge Write a report which will be assessed Collect information in order to solve a problem
LO3: Program Cobot systems, using programming and data processing techniques	Identify the use of different types of manual movements Recognize the parts of a robot cycle and relate them in the correct use Examine an automatic process and define the related robot program	Examine the available manual movement modes of a robot Relate the right manual mode with different situations Complete manual robot movement in all the available modalities Compare all the available movement	

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		functions and associate them with their use Use flow control functions to manage a cycle Use external input and output signals Develop programs with known functions	Organize time and tasks to solve the problem Resolve the incoming issues Validate the solutions by simulation and tests Supervise different tasks to solve the challenges Have a responsibility about different tasks into the team
LO4: Check the operation of Cobot systems, adjusting the control devices and applying safety regulations.	Define robot working area and relate the right safety regulation Examine a robot cycle, find issues and solve them	Choose the allowed/forbidden work areas and compute them in the robot system Analyze the use of the robot and find the correct safety configuration Test a robot cycle in manual or automatic mode Examine issues, find a solution and modify the program in the right way	
LO5: Configure Artificial Vision systems, selecting and connecting the component elements.	Define the general characteristics of artificial vision systems Identify camera's features Identify environmental conditions in AV systems	Connect AV systems with cobot Calibrate AV systems	
LO6: Program Artificial Vision systems to use with Cobot systems, using programming	Understand software features	Train objects with their characteristics (colour, shape…)	

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and data processing techniques.		Analyze the program in each case	

Structure

The module is structured in 3 units, while Unit 2 is further structured to subunits. Each unit/subunit has specific objectives and learning outcomes.

1. Introduction
2. Programming Cobots
   - 2.1 Programming Cobots - Manual Movements
   - 2.2 Programming Cobots - TCP Setting
   - 2.3 Programming Cobots - Working Space
   - 2.4 Programming Cobots - Point Teaching
   - 2.5 Programming Cobots - Movements 1
   - 2.6 Programming Cobots - Movements 2
   - 2.7 Programming Cobots - I/O Management
   - 2.8 Programming Cobots - Variables & Flow control
   - 2.9 Programming Cobots - Palletizing
3. Artificial Vision Systems

Learning methodology

- Seminars – presentation in the laboratory/class
- Demonstration of the robots
- Self-learning with the videos
- Experimentation with simulators
- Experimentation with robots (supervised by a teacher, safety aspects)
- Challenge- based learning (in laboratory)

Assessment

- Standardized test (multiple choice tests for each subunit)
- Exercises with the simulators
- Exercises with the robots
- Evaluation based on challenge-based learning (only with the robots)
- Report (10 / 15 pages)
- Oral defense of challenge-based learning based on a PowerPoint support

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Learning content

For each unit/subunit

- Video
- Operating mode (pdf file)
- Standardized assessment test (online)
- Activities / exercises

Two challenges (pdf files and video)

- Description of the challenge
- 3D printed parts
- Drawing templates
- Requirements – specifications
- Learning outcomes including soft skills
- Evaluation criteria
- Timing

Bibliography – resources

Stäubli manuals and documentation

Stäubli website

SensoPart manual

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Equipment and software

SRS (Stäubli Robotics Suite)

Visor Vision Sensopart

PowerPoint

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