Transnational CDS Vocational Curricula

October 2021

TALENTJOURNEY

With the support of the Erasmus+ Programme of the European Union

Deliverable Lead:	SATAEDU
Related Work Package:	WP4: Trans-national vocational curricula and life-long training in the manufacturing sector with the special focus on Connectivity Devices and Services/CDS (IoT in smart manufacturing) that provides user-oriented, user-friendly and eco-friendly solutions (4.0/5.0)
Related Task:	4.1 Transnational CDS vocational curricula – content design
Author:	SATAEDU, School Centre Nova Gorica, School centre Kranj, School Centre Velenje, I.S.I.S. A. Malignani, Tallinn Polytechnic School, CPI
Dissemination Level:	Public

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

Content

Key Competences

Each module contains at least key competencies included (ALKCI) by the alphabets in the chart below. There are few module specific ALKCI charts placed among the modules.

Green skills	A. Understands the implications of their decisions for sustainable development (Has environmental awareness and willingness to learn about sustainable technologies and understand the need for change, Names generic green skills, Reduces electricity consumption, rational consumption of energy) B. Has skills to facilitate holistic and interdisciplinary approaches (Finds cases of maximising resource efficiency and technologies, products and processes on sustainability) C. Understands environmental legislation (Takes account of new regulation and demographic and environmental changes)
Soft skills	D. Understands effective communication E. Uses work ethic F. Understands teamwork in conflict resolution G. Uses time management and efficiency H. Understands responsibility for project work I. Uses critical thinking and curiosity in solving problems J. Creativity and innovation skills K. Customer-oriented service development expertise and customer service skills L. Learning ability M. Problem solving skills N. Networking, partnership and collaboration skills O. Knowledge retrieval skills and knowledge assessment skills
Key Competences	P. Utilizing digital solutions Q. Utilization competence of digital platforms, management and control skills of digital functions and utilization competence of solutions R. Digital identity management and protection skills (tools and content) S. Business competence and understanding of earnings logic

Joint curricula IIOT

module 01

IIOT Holistic view

Level: EQF 4

Time frame: 20 h

Responsible partner: Sataedu

Holistic view IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of electrical engineering	Basics of automation technology	Fundamentals of digital technology and telecommunications	Electronic Measurements
▪ Current ▪ Voltage ▪ resistance ▪ Grounding	▪ bus technology (Ethernet…) ▪ Sensors ▪ Actuators (Motors, valves…) ▪ Basics of pneumatics ▪ Basics of hydraulics	▪ Basic logic circuits ▪ Basics of TCP / IP (IP number, subnet mask, default gateway, DHCP, DNS, DynDNS), ▪ VPN, Virtual Private Network,	▪ Use measuring devices ▪ power Measurements ▪ voltage Measurements ▪ Resistance

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 01	IIOT HOLISTIC VIEW
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4)
TIME FRAME:	20 HOURS

MODULE COMPETENCES:
1. Familiarises with IIOT and History
2. How IIOT works and available applications
3. Challenges, advantages, disadvantages in IIOT
4. Best IIOT practices

BUILT IN META SKILLS, GREEN SKILLS AND *KEY COMPETENCES*
▪ Development of self-directiveness; ▪ developing multitasking; ▪ developing cooperation and teamwork; ▪ developing flexibility; ▪ developing empathy and communication; ▪ development of resilience and perseverance ▪ *literacy* ▪ *languages* ▪ *digital*

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Gets familiar with IIOT and History ALKCI: G, H, I, L, O, P	▪ identifies different IIOT operating environments ▪ finds and analyses information for IIOT	The student knows the most IIOT environments and more about the history of IIOT. Learning material example: https://www.guru99.com/iot-tutorial.html#3	3
2.	How IIOT works and available applications ALKCI: B, G, H, I, L, M, O, P	▪ identifies the most typical IIOT sensors and devices ▪ selects suitable devices and takes into account the characteristics of IIOT data network devices	The student knows what makes a an IIOT gadget: • Sensors/Devices • Connectivity • Data Processing • User Interface The student knows IIOT applications: • Automotive connections • Intelligent supply chain • Parking sensors • Smart home • Sport applications • Temperature controls • Well-being sensor Learning material example: https://youtu.be/UrwbeOIlc68	7
3.	Challenges, advantages, disadvantages in IIOT ALKCI: B, G, H, I, J, L, M, O, P, R, S	▪ Identifies typical cybersecurity risks associated with the use of IIOT ▪ Knows the advantages, disadvantages and challenges of IIOT	The student recognises the challenges: Insufficient testing and updating Concern regarding data security and privacy Software complexity Data volumes and interpretation Integration with AI and automation Devices require a constant power supply which is difficult Interaction and short-range communication Advantages: Benefits in technical optimization Improving data collection Better process improvement Disadvantages: Cybersecurity Complexity Compliance Flexibility Privacy	3

4.	IIOT practical application exercise *	▪ Gets acquainted with IIOT application and analyses the structure of the application ▪ Explores the hardware & software ▪ Defines the best methods in applications	The student is able to define a good IIOT application. The student understands the structure of IIOT environment (sensors, connections, data, analysing)	7

*Each student chooses an existing IIOT-application and writes down the whole application, searches its history, where and how it's being used and which automation parts it consists of

Joint curricula IIOT

module 02

AI, EQF4 (3 YEARS)

Level: EQF 4

Time frame: 26 h

Responsible partner: ŠC Nova Gorica

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of statistics	Basics of programming	Fundamentals of databases	Using spreadsheets
▪ mean, median, modus ▪ standard deviation ▪ histogram	▪ variables ▪ statements ▪ control structures ▪ loops	▪ entities ▪ attributes ▪ relationships ▪ basics of SQL DML	▪ acquiring data ▪ using statistical functions ▪ drawing basic charts

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 02	AI
LEVEL OF DIFFICULTY:	LEVEL III (EQF 4 -3 YEARS)
TIME FRAME:	26 HOURS

MODULE COMPETENCES:
1. Recognize user needs and find intersection between user needs and AI strength 2. Collect and evaluate data needed

BUILT IN META SKILLS, GREEN SKILLS AND *KEY COMPETENCES*
▪ learn ethical collection of data ▪ developing multitasking ▪ developing cooperation and teamwork ▪ developing customer communication ▪ development of self-directiveness ▪ developing multitasking ▪ developing of resilience and perseverance ▪ using professional terminology in a foreign language (English)

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Recognize user needs and find intersection between user needs and AI strength ALKCI: D, G, H, J, I, M **	▪ identifies which users problems is AI positioned to solve;	▪ describes the fields where AI is used (computer vison, speech recognition, natural language processing, social network filtering, games, mobile advertising,…) ▪ finds the examples where AI is probably better and where rule or heuristic based solution will work o finds the examples of recommendation system, prediction system, personalization, image recognition, natural language understanding,… where AI adds value o finds examples of tasks where AI is probably not the way to go (limited or static information, complete transparency, optimizing for high speed and low cost,…) o discusses different use cases	10
2.	Collect and evaluate data needed ALKCI: C, F, K, Q	▪ queries data from multiple sources like relational databases, IOT devices, social networks, data warehouses ▪ knows law and ethical limitation when collecting data ▪ joins and aggregates collected data ▪ visualizes collected data ▪ describes the statistical properties of the data	▪ describes business rules behind given SQL database ▪ analyses data with SQL SELECT clause ▪ fetches and stores data from IOT device ▪ gets data with one of the social media analytics tools ▪ names the most important rules of GDPR (General Data Protection Regulation) ▪ reflects on ethical fetching of data ▪ explains null data and outliers in data ▪ visualizes data (Python, R or PowerBI, Excel,Google sheets,…) o draws line chart o draws bar chart o histogram	16

Joint curricula IIOT

module 03

AI, EQF 4 (4 years)

Level: EQF 4

Time frame: 66 h

Responsible partner: School Centre Nova Gorica

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of statistics	Basics of programming	Fundamentals of databases	Using spreadsheets
▪ mean, median, modus ▪ standard deviation ▪ histogram	▪ variables ▪ statements ▪ control structures ▪ loops ▪ object oriented programming	▪ entities ▪ attributes ▪ relationships ▪ basics of SQL DML	▪ acquiring data ▪ using statistical functions ▪ drawing basic charts

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 03	AI
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4)
TIME FRAME:	66 HOURS

MODULE COMPETENCES:
1. Recognize user needs and find intersection between user needs and AI strength
2. Collect and evaluate data needed
3. Build ML models and explain the results
4. Write an AI application

BUILT IN META SKILLS, GREEN SKILLS AND *KEY COMPETENCES*
▪ learn ethical collection of data;
▪ developing multitasking;
▪ developing cooperation and teamwork;
▪ developing customer communication

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Recognize user needs and find intersection between user needs and AI strength ALKCI: D, G, H, J, I, M **	▪ identifies which users problems is AI positioned to solve; ▪ asses automation vs. augmentation;	▪ describes the fields where AI is used (computer vison, speech recognition, natural language processing, social network filtering, games, mobile advertising,…) ▪ finds the examples where AI is probably better and where rule or heuristic based solution will work ▪ finds the examples of recommendation system, prediction system, personalization, image recognition, natural language understanding,… where AI adds value ▪ finds examples of tasks where AI is probably not the way to go (limited or static information, complete transparency, optimizing for high speed and low cost,…) ▪ discusses different use cases ▪ defines user needs, possible solutions and assess whether AI can solve the problem in unique way	6
2.	Collect and evaluate data needed ALKCI: C, F, K, Q	▪ queries data from multiple sources like relational databases, IOT devices, social networks, data warehouses ▪ knows law and ethical limitation when collecting data ▪ joins and aggregates collected data ▪ visualizes collected data ▪ describes the statistical properties of the data	▪ describes business rules behind given SQL database ▪ analyses data with SQL SELECT clause ▪ fetches and stores data from IOT device ▪ gets data with one of the social media analytics tools ▪ names the most important rules of GDPR (General Data Protection Regulation) ▪ reflects on ethical fetching of data ▪ describes statistics of data (mean, median, modus, standard deviation) ▪ explains null data and outliers in data ▪ visualizes data (Python, R or PowerBI, Excel, Google sheets,…) o draws line chart o draws bar chart o draws histogram o draws scatter plot	10

3.	Build ML models and explain the results ALKCI: G, E, P, N, O, R	▪ explains the difference between supervised, reinforcement and unsupervised machine learning ▪ identifies different ML methods for classification, regression and clustering ▪ uses standard libraries ML methods ▪ explains the result ▪ illustrates how neural network works ▪ summarizes properties of deep learning	▪ uses one of the classification algorithm (naive Bayes, decision tree, random forest, logistic regression, support vector machines or K nearest neighbours) on example data ▪ evaluates results of classification ▪ uses one of the regression algorithm (linear regression, logistic regression, boosted decision tree or other) on example data ▪ evaluates results of regression ▪ uses neural network for classification and regression ▪ explains what is deep learning ▪ justifies use of specific method to get better results ▪ makes predictions on test data ▪ compares the results of written neural network with results of the standard libraries like Keras, scikit-learn, … ▪ names deep learning use cases ▪ reviews properties of the artificial neural networks (feedforward neural network, recurrent neural networks, convolutional neural network)	35
4.	Write an AI application ALKCI: A, B, S, P, L	▪ uses image recognition in business application	▪ names different approaches for image recognition (simple object detection, image matching, image recognition using ML, advanced image recognition) and finds an example of each approach ▪ names differences between image detection an image recognition ▪ finds different use cases of image recognition	15

Joint curricula IIOT

module 04

AI, EQF 5

Level: EQF 5

Time frame: 120 h (100-200h)

Responsible partner: School Centre Nova Gorica

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of statistics	Basics of programming	Fundamentals of databases	Using spreadsheets
▪ mean, median, modus ▪ standard deviation ▪ histogram	▪ variables ▪ statements ▪ control structures ▪ loops ▪ object oriented programming	▪ entities ▪ attributes ▪ relationships ▪ basics of SQL DML	▪ acquiring data ▪ using statistical functions ▪ drawing basic charts

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 04	AI
LEVEL OF DIFFICULTY:	LEVEL V (EQF 5)
TIME FRAME:	120 HOURS

MODULE COMPETENCES:
1. Recognize user needs and find intersection between user needs and AI strength
2. Collect and evaluate data needed
3. Build ML models and explain the results
4. Write an AI application

BUILT IN META SKILLS, GREEN SKILLS AND *KEY COMPETENCES*
▪ learn ethical collection of data; ▪ developing multitasking; ▪ developing cooperation and teamwork; ▪ developing customer communication

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Recognize user needs and find intersection between user needs and AI strength ALKCI: D, G, H, J, I, M **	▪ identifies which users problems is AI positioned to solve; ▪ asses automation vs. augmentation; ▪ designs and evaluates reward function;	▪ describes the fields where AI is used (computer vison, speech recognition, natural language processing, social network filtering, games, mobile advertising,…) ▪ finds the examples where AI is probably better and where rule or heuristic based solution will work o finds the examples of recommendation system, prediction system, personalization, image recognition, natural language understanding,… where AI adds value o finds examples of tasks where AI is probably not the way to go (limited or static information, complete transparency, optimizing for high speed and low cost,…) o discusses different use cases ▪ defines user needs, possible solutions and assess whether AI can solve the problem in unique way ▪ explains what is confusion matrix (defines true positive, true negative, false positive an false negative outcomes on example) ▪ assess whether is more important precision or recall ▪ addresses fairness for all users ▪ prepares the plan to monitor application over time	10
2.	Collect and evaluate data needed ALKCI: C, F, K, Q	▪ queries data from multiple sources like relational databases, IOT devices, social networks, data warehouses ▪ knows law and ethical limitation when collecting data ▪ joins and aggregates collected data ▪ visualizes collected data ▪ describes the statistical properties of the data ▪ finds correlations between data	▪ describes business rules behind given SQL database ▪ analyses data with SQL SELECT clause ▪ fetches and stores data from IOT device ▪ gets data with one of the social media analytics tools ▪ explains value of social media data ▪ names the most important rules of GDPR (General Data Protection Regulation) ▪ reflects on ethical fetching of data ▪ plans new ways of collecting data ▪ joins collected data from multiple sources ▪ describes statistics of data (mean, median, modus, standard deviation) ▪ explains null data and outliers in data ▪ visualizes data (Python, R or PowerBI, Excel,Google sheets,…) o draws line chart o draws bar chart o draws histogram o draws scatter plot ▪ discuses correlation between data	10
3.	Build ML models and explain the	▪ explains the difference between supervised,	▪ uses one of the classification algorithm (naive Bayes, decision tree, random forest, logistic	40

	results ALKCI: G, E, P, N, O, R	reinforcement and unsupervised machine learning ▪ identifies different ML methods for classification, regression and clustering ▪ uses standard libraries ML methods ▪ explains the result ▪ illustrates how neural network works ▪ builds neural network from scratch ▪ summarizes properties of deep learning	regression, support vector machines or K nearest neighbours) on example data ▪ evaluates results of classification ▪ uses one of the regression algorithm (linear regression, logistic regression, boosted decision tree or other) on example data ▪ evaluates results of regression ▪ uses K-means clustering method on example data ▪ uses neural network for classification and regression ▪ explains what is deep learning ▪ justifies use of specific method to get better results ▪ writes program to prepare data for neural network, splits data into train and test set, normalizes data ▪ designs function for forward propagation in a programing language ▪ writes function for backpropagation ▪ trains neural network using specific data and labels ▪ makes predictions on test data ▪ compares the results of written neural network with results of the standard libraries like Keras, scikit-learn, … ▪ names deep learning use cases ▪ reviews properties of the artificial neural networks (feedforward neural network, recurrent neural networks, convolutional neural network) ▪ trains deep learning models (keras, pytorch,…)	
4.	Write an AI application ALKCI: A, B, S, P, L	▪ uses image recognition in business application ▪ creates a recommender system ▪ explores time series data ▪ performs text analysis ▪ writes a chatbot	▪ names different approaches for image recognition (simple object detection, image matching, image recognition using ML, advanced image recognition) and finds an example of each approach ▪ names differences between image detection an image recognition ▪ finds different use cases of image recognition ▪ uses collaborative filtering, content based filtering for recommending choices ▪ writes a simple recommender system ▪ examines properties of time series objects ▪ plots time series data ▪ decomposes time series data into trend, seasonal and reminder components ▪ models the reminder components as AR, MA, ARMA and ARIMA models ▪ creates and evaluates difference series ▪ constructs and evaluates forecasting model ▪ prepares unstructured text for deeper analysis ▪ names text analysis techniques like word frequency, collocation, concordance ▪ uses pre-trained classifiers for sentiment analysis	60

		▪ invents a game where one of the player is AI Green skills: ▪ Has environmental awareness and willingness to learn about sustainable technologies and understand the need for change ▪ Has skills to facilitate holistic and interdisciplinary approaches Soft skills: ▪ Can effectively communicate verbal and nonverbal ▪ Knows how to listen actively and resolve conflicts in teams Understands responsibility for project work	▪ finds use cases for text analysis in business applications ▪ discusses the added value for business when using chatbots ▪ creates scenario for bot ▪ writes a bot using an existing framework ▪ explains what is a game AI and constraints of games AI development ▪ writes a game with hardcoded conditional statements ▪ finds the way to collect needed data for improving the game ▪ performs basic weight-based adaptation (reinforced learning) ▪ adapts the games with learning	

Joint curricula IIOT

module 05

Augmented reality (AR)

Level: EQF 5

Time frame: 100 h (100-200h)

Responsible partner: Tallinn Polytechnic School

Holistic view IIOT module

Basics of electrical engineering	Basics of programming	Fundamentals of databases	Using spreadsheets
▪ current ▪ voltage ▪ resistance ▪ power ▪ Ohms law ▪ Kirchhoff's laws	▪ variables ▪ statements ▪ control structures ▪ loops ▪ object oriented programming	▪ entities ▪ attributes ▪ relationships ▪ basics of SQL DML	▪ acquiring data ▪ using statistical functions ▪ drawing basic charts

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 05	AUGMENTED REALITY (AR)
LEVEL OF DIFFICULTY:	LEVEL V (EQF 5)
TIME FRAME:	100 HOURS

MODULE COMPETENCES:
1. Green skills
2. Sets up and uses a VR and AR system
3. Gets acquainted with the opportunities of the VR and AR technologies
4. Combines AR with AI
5. Gets acquainted with the health and safety risks in VR and AR technologies

BUILT IN META SKILLS, GREEN SKILLS AND *KEY COMPETENCES*
▪ learn ethical collection of data; ▪ developing multitasking; ▪ developing cooperation and teamwork; ▪ green skills ▪ holistic approach to AI & AR ▪ customer communication

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Green skills ALKCI: A, B, C, D, J	▪ uses basic, transferable and technical green skills which can be applied across industries and occupations.	▪ names different basic, transferable and technical green skills ▪ finds use cases where greenskills are economically feasible	10
2.	Sets up and uses a VR and AR system ALKCI: D, F, G, L, M, N, S	▪ identifies the difference in both technologies ▪ identifies the devices and tools needed to set up the systems ▪ knows the terminology of the technologies ▪ follows and interprets the documents, instructions and plans required for the setup of the systems	▪ knows the most common VR and AR systems (both software and hardware) ▪ understands the general operating principles of the systems ▪ understands the ways the systems could be connected together	25
3.	Gets acquainted with the opportunities of the VR and AR technologies ALKCI: B, E, F, G, H, L, Q, S	know the different usecases in both technologies: ▪ Urban design & planning ▪ STEM education ▪ Commerce ▪ Visual art ▪ Fitness ▪ Social interaction ▪ Video games ▪ Industrial design ▪ Healthcare planning, practice and education ▪ Spatial immersion and interaction ▪ Flight training ▪ Navigation ▪ Workplace ▪ Broadcast and live events ▪ Tourism and sightseeing ▪ Translation ▪ Social media ▪ etc...	▪ identifies the difference and the possible usecases in both technologies ▪ knows where to use and prefer one system over the other	35
4.	Combines AR with AI ALKCI: B, H, I, J, K, M, N, P, Q	▪ pick a suitable use case and implements it using AR with AI ▪ gets acquainted with AR developing software	▪ Can use AI to replace a face/object in AR screen/view ▪ Can create a navigation app that shows the way on the road in the "viewfinder" of a smart device ▪ Can create an app that translates text from image and tries to replace the original text. ▪ Can create a videogame htat uses AR ▪ Can create an interactive AR info center for tourist or clients ▪ etc...	20
5.	Gets acquainted with the health and safety risks in VR and AR technologies ALKCI: C, O, R	Obtains the knowledge about: ▪ Reality modifications ▪ Privacy concerns ▪ Health and safety ▪ Children in virtual reality ▪ Conceptual and philosophical concerns	The students are able to protect themselves from the dangers that inherently come with VR and AR	10

Joint curricula IIOT

module 06

Cyber Security, EQF 4 (3 years)

Level: EQF 4 (3 years)

Time frame: 50h

Responsible partner: School Centre Nova Gorica

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of: • networks		Basics of:				

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 06	CYBER SECURITY
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4 -3 YEARS)
TIME FRAME:	50 HOURS

MODULE COMPETENCES:
1. Basic security concepts
2. Cryptography
3. Secure network administration
4. Threat and vulnerability assessment
5. Incident detection, response and remediation

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Basic security concepts ALKCI: A, D, L	• Lists basic security elements. • Lists standards affecting cybersecurity. • Secure the electronic device or information source.	• Defines principles of information security. • Describes authentication, authorization, access control, and data integrity. • Performs data and network backup. • Identifies security threats and attacks.	10
2.	Cryptography ALKCI: B, E, L	• Understand basic elements of cryptography. • Distinguish the difference between a code and a cipher and explain the basic types of ciphers. • Lists basic cryptographic algorithms. • Describe digital signature and usage.	• Describes basic cryptography terminology. • Lists fundamental principles of cryptography. • Differentiates between symmetric and asymmetric encryption. • Describes public and private key pairs concept.	15
3.	Secure network administration ALKCI: A, E, F	• Identify anomalies in network traffic. • Lists network infrastructure vulnerabilities. • Understand group policies and access control lists. • Install or replace network hubs, routers and switches.	• Describe TCP communication. • Describe basic subnetting. • Describe network terminology. • Identifies wireless network types. • Lists wireless encryption algorithms.	10
4.	Threat and vulnerability assessment ALKCI: A, F	• Identify critical target elements. • Identify threat tactics and methodologies. • Identify malicious activity.	• Describe malware types. • Understands root causes of vulnerabilities. • Describe DDoS attacks. • Describe sniffing tools.	10
5.	Incident detection, response and remediation ALKCI: D, F, I	• Monitor continuously for any incidents or threats. • Disccuss about the instances of cyber attacks. • Reports security status of a system.	• Performs installation and usage of intrusion detection system. • Explaines purpose of firewall. • Provides incident reports and findings.	5

Joint curricula IIOT

module 07

Cyber Security, EQF 4 (4 Years)

Level: EQF 4

Time frame: 100 h (100-200h)

Responsible partner: School Centre Nova Gorica

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of: • networks		Basics of: • programming languages				

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 07	CYBER SECURITY
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4)
TIME FRAME:	100 HOURS

MODULE COMPETENCES:

1. Basic security concepts
2. Cryptography
3. Secure network administration
4. Threat and vulnerability assessment
5. Web based risks mitigation
6. Penetration testing

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Basic security concepts ALKCI: A, D, L	Lists basic security elements. • Lists basic security elements. • Understand concepts of confidentiality, integrity, availability and other security concepts. • Lists laws, acts, policies and standards affecting cybersecurity. • Secure the electronic device or information source. • Maintain awareness of advancements in hardware and software technologies and their potential implications	• Defines principles of information security. • Describes concepts of confidentiality, integrity, availability and non-repudiation. • Describes the concepts of authentication, authorization, access control, and data integrity. • Lists laws, regulations and ethical principles of cybersecurity and information security instructions • (e.g. GDPR, ISO, ...). • Performs data and network backup. • Identifies IoT security threats and attacks. • Promotes the value of IT security through all levels of the organisation.	15
2.	Cryptography ALKCI: B, E, L	• Understand basic elements of cryptography. • Distinguish the difference between a code and a cipher and explain the basic types of ciphers. • Lists basic cryptographic algorithms. • Describe digital signature components and usage.	• Describes basic cryptography terminology. • Lists fundamental principles of cryptography. • Discuss the role that confidentiality, integrity and nonrepudiation play in cryptosystems. • Differentiates between symmetric and asymmetric encryption. • Describes how ciphers work. • Generate public and private key pairs. • Lists encryption communication methods.	20
3.	Secure network administration ALKCI: A, E, F	• Identify and analyze anomalies in network traffic. • Secure the perimeter of the IoT network. • Evaluate network infrastructure vulnerabilities. • Examine network topologies. • Design group policies and access control lists. • Install or replace and configure or optimize network hubs, routers, and switches. • Report significant network events and intrusions	• Describe TCP communication. • Describe basic subnetting. • Describe wireless network architecture and terminology. • Identifies wireless network types. • Lists wireless encryption algorithms. • Understands basic elements of cloud security.	15

4.	Threat and vulnerability assessment ALKCI: A, F	• Identify and assess the main threats and effects of a cyber attack. • Identify critical target elements. • Identify threat tactics and methodologies. • Identify malicious activity. • Check integrity and authenticity of programs.	• Describe malware types, deployment methods and countermeasures. • Identifies root causes of vulnerabilities. • Describe DDoS attacks and techniques. • Describe session hijacking. • Describe sniffing tools and understand their output.	15
5.	Web based risks mitigation ALKCI: A, F	• Identify features of common web server architecture. • Identify web server and application vulnerabilities. • Describe web server and web application attacks.	• Explains most common vulnerabilities in modern web servers. • Reflects on vulnerabilities of web protocols. • Distinguish different stages in web server attack methodology.	25
6.	Incident detection, response and remediation ALKCI: D, F, I	• Monitor continuously for any incidents or threats. • Analyze instances of cyber attacks and discuss design principles that could have prevented them. • Reports security status of a system.	• Describes types of intrusion detection systems. • Performs installation and configuration of intrusion detection system. • Explaines firewall and honeypots use and placement. • Prepares incident response action plans. • Provides incident reports and findings.	10

Joint curricula IIOT

module 08

Cyber Security, EQF 5

Level: EQF 5

Time frame: 160 h (100-200h)

Responsible partner: School Centre Nova Gorica

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

Basics of: • networks protocols		Basics of: • programming languages ematics: basics of statistics				

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

.

MODULE 08	CYBER SECURITY
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 5)
TIME FRAME:	160 HOURS

MODULE COMPETENCES:
1. Basic security concepts 2. Cryptography 3. Secure network administration 4. Threat and vulnerability assessment 5. Web based risks mitigation 6. Penetration testing 7. Incident detection, response and remediation

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Basic security concepts ALKCI: A, D, L	Lists basic security elements. • Understand and apply concepts of confidentiality, integrity, availability and other security concepts. • Identify laws, acts, policies and standards affecting cybersecurity. • Secure the electronic device or information source. • Maintain awareness of advancements in hardware and software technologies and their potential implications.	• Describes principles of information security. • Maintains baseline security according to organizational cyber policies. • Promotes the value of IT security through all levels of the organisation. • Describes concepts of confidentiality, integrity, availability and non-repudiation. • Describes the concepts of authentication, authorization, access control, and data integrity. • Lists and uses basic laws, regulations and ethical principles of cybersecurity and information security instructions (e.g. GDPR, ISO 27 000, ...). • Performs data and network backup. • Identifies IoT security threats and attacks. Analyses existing IoT use cases and applications across industries.	15
2.	Cryptography ALKCI: B, E, L	• Understand basic elements of cryptography. • Distinguish the difference between a code and a cipher and explain the basic types of ciphers. • Lists basic cryptographic algorithms. • Describe digital signature components and usage.	• Describes basic cryptography terminology. • Discuss fundamental principles of cryptography. • Discuss the role that confidentiality, integrity and nonrepudiation play in cryptosystems. • Differentiates between symmetric and asymmetric encryption. • Describes how transposition ciphers, substitution ciphers, stream ciphers and block ciphers work. • Generate public and private key pairs. • Lists encryption communication methods (e.g. SSH, SSL, TSL, IPSec, ...). • Explains key exchange protocols (e.g. Diffie–Hellman Algorithm)	20

3.	Secure network administration ALKCI: A, E, F	• Identify and analyze anomalies in network traffic. • Secure the perimeter of the IoT network. • Evaluate network infrastructure vulnerabilities and identify potential points of strength and vulnerability within a network. • Examine network topologies to understand data flows through the network. • Design group policies and access control lists. • Install or replace and configure or optimize network hubs, routers, and switches. Report significant network events and intrusions.	• Describe TCP communication (three-way handshake and flag types). • Describe basic subnetting. • Describe wireless network architecture and terminology. • Identifies wireless network types and forms of authentication. • Describe wireless encryption algorithms. • Identifies wireless hacking methods and tools. • Describe mobile platform attacks. • Identifies mobile platforms vulnerabilities and attack vectors. • Understands basic elements of cloud security. Identifies cloud security tools.	20
4.	Threat and vulnerability assessment ALKCI: A, F	• Identify and assess the main threats and effects of a cyber attack. • Identify critical target elements. • Identify threat tactics and methodologies. • Analyze identified malicious activity. • Develop risk mitigation strategies to resolve vulnerabilities and recommend security changes. • Apply measures to check integrity and authenticity of programs. Recognize the importance of open and effective communication. .	• Describe malware types, deployment methods and countermeasures. • Identifies root causes of vulnerabilities. • Describe DDoS attacks and techniques. • Identifies DoS detection and countermeasure action. • Describe session hijacking and sequence prediction. • Describe sniffing tools and understand their output. • Prepares a security assessment report.	20
5.	Web based risks mitigation ALKCI: A, F	• Identify features of common web server architecture. • Identify web server and application vulnerabilities. • Describe web server and web application attacks. Identify web application hacking tools.	• Identifies most common vulnerabilities in modern web servers. • Reflects on vulnerabilities of web protocols. • Explains web application security flaw selected from OWASP top ten list. • Defines different stages in web server attack methodology. Uses program tools to test web applications vulnerabilities.	30
6.	Penetration testing ALKCI: B, F, G	• Understand the use of social networking, search engines, and Google hacking in information gathering	• Describes ethical hacking techniques. • Lists IoT hacking methodology.	40

		• Design, prepare and perform authorized or simulated penetration testing of applications and systems. • Use automated security assessment tools to perform security assessments of IoT solution components. • Facilitate the sharing of "best practices" and "lessons learned" throughout the cyber operations community. Document penetration testing results and suggest improvements.	• Differentiates between active and passive information gathering about selected target. • Uses program tools to gather information about target systems. • Describes methods used to gain access to systems. • Describes methods used to escalate privileges. • Reflects on IoT security and hacking technologies.	
7.	Incident detection, response and remediation ALKCI: D, F, I	• Monitor continuously for any incidents or threats across the IoT stack. • Perform analysis of log files from a variety of sources. • Analyze instances of cyber attacks and discuss design principles that could have prevented them. • Develop incident response action plans. • Discuss methods to neutralize the effects of the incident and restore fully operational system capability after it.	• Describes types of intrusion detection systems. • Performs installation and configuration of selected intrusion detection system. • Evaluates gathered data from intrusion detection systems. • Explaines firewall and honeypots use and placement. • Reports security status of a system. • Prepares incident response action plans. • Provides incident reports and findings. Implements measures to secure data across IoT solutions.	15

Joint curricula IIOT

module 09

Robotics engineering, EQF 4 (3 year)

Level: EQF 4 (3 year)

Time frame: 200 h (100-200h)

Responsible partner: Sataedu

Holistic view IIOT module

Basics of electrical engineering	Basics of automation technology	Fundamentals of digital technology and telecommunications	Electronic Measurements
▪ Current ▪ Voltage ▪ resistance ▪ Grounding	▪ bus technology (Ethernet…) ▪ Sensors ▪ Actuators (Motors, valves…) ▪ Basics of pneumatics ▪ Basics of hydraulics	▪ Basic logic circuits ▪ Basics of TCP / IP (IP number, subnet mask, default gateway, DHCP, DNS, DynDNS), ▪ VPN, Virtual Private Network,	▪ Use measuring devices ▪ power Measurements ▪ voltage Measurements ▪ Resistance

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 09	ROBOTICS ENGINEERING
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4)
TIME FRAME:	200 HOURS

MODULE COMPETENCES:
1. Prepare for the installation of robotics and computer network equipment.
2. Make the installation and commissioning of the robot and IIOT computer network equipment.
3. Use a robot and a robot cell.
4. Perform robot maintenance, service and documents the installation of computer network equipment.

BUILT IN META SKILLS, GREEN SKILLS AND *KEY COMPETENCES*
▪ Development of self-directiveness; ▪ developing multitasking; ▪ developing cooperation and teamwork; ▪ developing flexibility; ▪ developing empathy and communication; ▪ development of resilience and perseverance ▪ *literacy* ▪ *languages* ▪ *digital*

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Prepare for the installation of robotics and computer network equipment. ALKCI: A, B, C, E, G, L, M, O	▪ identifies different mechanical structures and types of robots, as well as the operating principles of electronic motion controls; ▪ identifies devices and tools related to the control, management and operation of the robot and knows their operating principles; ▪ knows the most typical IIOT sensors and interprets the correctness of the information; ▪ Identifies typical security risks associated with the use of robots; ▪ knows the automation process for the company's competitiveness; ▪ interprets the operation of equipment and components of an industrial robotics system on the basis of documents, instructions and plans; ▪ follows and interprets the documents, instructions and plans required for the installation of computer network equipment; ▪ ensures tools, protectors and materials required for the installation of computer network equipment and ensure their condition; ▪ selects suitable devices and takes into account the characteristics of IIOT data network devices; ▪ knows the structure and protocols of the data network; ▪ plans and prepares the installation work; ▪ plans an efficient material use and recycling.	The student knows the most common robots and understands the general operating principles of robots, as well as understands the use of IIOT in data collection and control. The student becomes acquainted with the basics of robotics and computer network installations. The student delves into IIOT sensor technology and actuators.	40
2.	Make the installation and commissioning of the robot and IIOT computer network equipment. ALKCI: A, B, E, H, M, I, J, R,	▪ installs the industrial robot in accordance with current regulations, standards, manufacturer's instructions and customer environment requirements ▪ ensure the tools, protectors and materials required for the installation of the industrial robot and ensure their condition ▪ install and secure the robot to its permitted platforms and positions ▪ selects the cable types suitable for robot cabling	The student knows how to install and commission the robot using the correct materials and installation methods	50

		▪ connects the robot's power and compressed air supply as well as the IIOT control and safety devices ▪ Connects and configures various IIOT motion sensors and motor drives used in robots ▪ performs pneumatic, electrical and mechanical installations of robotic tools ▪ installs, connects and adjusts the most typical sensors and actuators related to the robot's equipment and tool, and is able to connect them to the robot's I / O terminals ▪ takes care of the finishing and cleanliness of the installation environment and the sorting of waste generated during installation work ▪ install robot and robot cell safety devices, safely use guards, tools and materials in accordance with the instructions ▪ install IIOT network equipment in accordance with applicable regulations, standards, manufacturer's instructions and customer environment requirements ▪ connects, configures and tests IIOT active devices to the telecommunication network ready for use and secure		
3.	Use a robot and a robot cell. ALKCI: A, B, M, P, S,	▪ knows the different programming methods and techniques of the robot and the benefits they can achieve ▪ create and utilize coordinate systems ▪ use robot inputs and outputs for robot programming changes ▪ Start, control and stop the robot safely ▪ makes an emergency stop of the robot or robot cell ▪ starts the robot after an emergency stop and an error condition ▪ makes changes to the robot's operation ▪ is aware of the consequences of a downtime	The student is able to use a robot cell, make changes to the operation, understand the importance of safe and economical use. Operation can be done locally and remotely using IIOT.	80

4.	Perform robot maintenance, service and documents the installation of computer network equipment. ALKCI: A, B, K, M, N, R, S,	▪ performs the necessary electronic measurements in his / her work, interprets the measurement results obtained and takes the necessary measures on the basis of the measurement results ▪ locate and repair faults ▪ service the robot according to the instructions ▪ Check the calibration of the robot axes and update the Tachometers ▪ interprets robot error logs ▪ use management software to monitor the telecommunications network and active devices ▪ Detects, locates and corrects faults ▪ document the implementation of the computer network solution in accordance with workplace practices	The student is able to service and maintain a robot, communication connections and document changes. Some of the maintenance tasks can be performed locally and some also with the help of IIOT.	30

Joint curricula IIoT

module 10

Robotics engineering, EQF 4 (4 years)

Level: EQF 4 (4 years)

Time frame: 136 h (100-200h)

Responsible partner: School Centre Velenje

Holistic view IIOT module

Basics of electrical engineering	Basics of automation technology	Fundamentals of digital technology and telecommunications	Electronic Measurements
▪ Current ▪ Voltage ▪ Resistance ▪ Capacitance ▪ Basic electronic elements	▪ Sensors ▪ Actuators (types of motors and valves) ▪ Basics of pneumatics and hydraulics ▪ Control and regulation tehnology	▪ Basic logic circuits ▪ Basics of TCP / IP (IP number, subnet mask, default gateway, DHCP, DNS, DynDNS), ▪ VPN, Virtual Private Network, ▪ Industrial networks (Profinet, modbus, profinet,…) ▪ Bus technology	▪ Use of measuring devices ▪ power Measurements ▪ voltage Measurements ▪ Resistance ▪ Curremt measurements ▪ Incremental and absolute encoder

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 10	ROBOTICS ENGINEERING
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4)
TIME FRAME:	136 HOURS

MODULE COMPETENCES:
1. Basic understanding of robotic manipulation and preparing the installation of robotics and computer network equipment. 2. Using a robot in a robot cell and using robotic cell design methods. 3. Make the installation and commissioning of the robot and IIoT computer network equipment. Understanding the basics of SCADA, OPC, data acquisition. 4. Evaluate the achieved properties. Project documentation, application maintenance, service of robot and computer network equipment.

No.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Basic understanding of robotic manipulation and preparing the installation of robotics and computer network equipment. ALCKI: D, G, L, I	▪ Introduction to robotics - official international definitions - areas of application of industrial robots - difference between robot and automaton ▪ basic structures of robots ▪ causes of robotics - introduction of robotics-economy Safety when working with robots ▪ Robotic basics, general principles of working with robots, safety, and protection of working with robots. ▪ Identifies different mechanical structures and types of robots, as well as the operating principles of electronic motion controls. ▪ types of segments and joints ▪ degrees of freedom - not redundant and redundant edge ▪ programming languages ▪ off-line and online programming	The student defines what is a robot. Knows the history of robotics, lists the use of industrial robots, distinguishes between robot types and distinguishes robot by number of axes. The student knows the most common robots and understands the general operating principles of robots as well as knows the basic principles of safe work with robots, hazards for robot operator and knows how to use safety equipment. The student lists reasons for using industrial robots, understands the coordinate systems and knows the safety instructions for working with robots.	36
2.	Using a robot in a robot cell and using robotic cell design methods. ALCKI: A, J, H, M, K	▪ Knows the types of segments and joints ▪ Explains the rotational joint ▪ Explains the translational joint ▪ Distinguishes between redundant and non-redundant robot ▪ Distinguishes and describes different coordinate systems ▪ robot workspace in different cases ▪ selection of the appropriate industrial robot ▪ presentations of the robot workspace ▪ grippers and tools, load, speed, reliability ▪ integration of a robot in applications	The student can use a robot cell, make changes to the operation, understand the importance of safe and economical use. The student uses simulation programs and CAD models to build a robotic cell. The student knows how to install and commission the robot using the correct installation methods.	36
3.	Make the installation and commissioning of the robot and IIoT computer network equipment. Understanding the basics of SCADA, OPC, data acquisition. ALCKI: A, E,	▪ understanding the operation of industrial networks ▪ understanding the basic principles of SCADA, visualization and how to visualize the industrial process ▪ understanding the basics of an OPC server and data acquisition ▪ understanding the basics principles of IIoT and its use. ▪ knows the structure and protocols of the data network and selects suitable devices and considers the characteristics of IIoT data network devices.	The student becomes acquainted with the basics of robotics and computer network installations The student understands the hierarchy of automation, types of data transfer, describes the means of transmission and knows the basic characteristics of the network. Operation can be done locally and remotely using IIoT.	36

		▪ understanding the basic of manufacturing execution system (MES) ▪ Using a IIoT application, using remote control		
4.	Evaluate the achieved properties. Project documentation, application maintenance and service of robot and computer network equipment. ALCKI: B, C, F	▪ Project evaluation and documentation ▪ Application maintenance ▪ Maintenance of robot cells and computer network equipment. ▪ Troubleshooting - detects, locates, and corrects faults ▪ interprets robot error logs, use management software to monitor the telecommunications network and active devices	The student can service and maintain a robot, communication connections and document changes. Some of the maintenance tasks can be performed locally and some also with the help of IIoT application.	28

Joint curricula IIOT

module 11

Robotics engineering, EQF 5

Level: EQF 5

Time frame: 180 h

Responsible partner: ISIS A. Malignani

Holistic view IIOT module

Fundamentals of Physics ▪ Reference systems: three-dimensional Cartesian triad, relative and absolute system ▪ Body movements of the rigid body: translation and rotation, Euler angles ▪ Kinematics: position, displacement, speed, acceleration	Computer Science elements ▪ Computer literacy ▪ Programming principles ▪ Internet Protocol v4 (Ipv4)	Elements of Mechanics and Technology ▪ Measurement and control instruments (centesimal comparator) ▪ Gears, reducers, transmissions, gear ratio ▪ Accident Prevention and Work Safety	Electrical Engineering elements ▪ Fundamentals ▪ Electric motors ▪ I/O communication and FieldBUS ▪ Automation and PLC

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 11	ROBOTICS ENGINEERING
LEVEL OF DIFFICULTY:	LEVEL V (EQF 5)
TIME FRAME:	160 HOURS

MODULE COMPETENCES:
1. Creation of movement programs for single use (without collaboration in synchronism with other machines and robots)
2. Configure robot communication with field devices.
3. Robot operation by programmable logic controller (PLC).
4. Perform software and mechanical robot maintenance.

No.	Competence	Professional skills	Learning outcomes	Time frame
1.	Practice with the programming terminal ALKCI: G, I, L, O, P, Q, R, S	• navigation keys on the touch screen panel and membrane keyboard • access to the system: initial screen, predefined users and users permissions architecture, creation and deletion of users • configuration of language, date and time, IPv4 address • status, warning and error message display indications • management of warning and error messages	Familiarize yourself with the robotic arm management tool, learn about the main functions of the keys and know how to orient yourself in the display screens.	10
2.	Acquisition of reference systems ALKCI: B, I, L, O, P, Q, R	• absolute coordinates: angles of rotation of the individual axes • relative coordinates: reference systems of the environment, base, work surface, flange and tool, dependence between them and relative positions identified by the coordinates of the origin and the Euler angles; local tool and work surface, remote tool and work surface • insertion of the base reference systems and local tool reference system • determination of the unknown local tool reference system and its insertion (test tool method and "4-point method") • empirical verification of the local tool reference system • determination of the reference system of the local work surface and its insertion • empirical verification of the local work surface reference system • determination of the unknown remote tool reference system and its insertion (test tool method and "4-point method") • empirical verification of the remote tool reference system • determination of the unknown remote work surface reference system and its insertion	Accurate understanding of spatial reference systems, the reasons for their use and the differences. Knowing how to determine, insert and activate the reference systems configurable by the operator in the system.	20

		• empirical verification of the remote work surface reference system • activation of reference systems		
3.	Manual movement of the robotic arm ALKCI: B, I, L, O, P, Q	• selection of operation: for programming, for autonomous execution of programs in memory, for PLC-controlled execution of programs in memory • adjustment of the percentage speed of the movements from the programming terminal • the enabling keys and the manual movement keys of the programming terminal: operation in absolute and relative coordinates (coordinates of the work surface reference system and of the tool reference system)	Knowing how to manually move the robotic arm in order to bring it to the various work positions to be acquired.	10
4.	Movement programming - Part 1: basics ALKCI: B, I, L, O, P, Q	• creation of a program • first code instruction: insertion of the reference systems of the tool and the work surface (already entered in the system), activation of them • configuration of position acquisition: acquisition in absolute or relative coordinates, movement trajectories in a shorter time, linear and arc-of-circle • second line of code: acquisition of the initial position out of space in absolute coordinates with movement in less time • acquisition of work positions in absolute coordinates with linear movement • last line of code: return to the same out of space position in absolute coordinates and linear trajectory • program files in memory and their management • execution of the movement program in programming mode and in local mode	Creation and execution of simple movement programs by acquiring the working positions.	25
5.	Movement programming - 2nd part: use of variables	• management of code lines: modify, copy, paste, delete • management of acquired work positions: modify, copy, paste, delete	Creation and execution of motion programs with not only linear trajectories, with or without termination, use of variables to influence	15

	ALKCI: B, I, L, O, P, Q	• the arc-of-circle trajectory • introduction of variables at the level of single instruction and as global • variable orientation for the arc-of-circle trajectory to avoid collisions with a object • movements with termination: variables that affect their accuracy • continuous movements: connection of trajectories and variables that affect their accuracy • percentage speed, acceleration and deceleration variables at program and device level, their mutual influence and dependence with the percentage speed set at the level of keys on the terminal	positions, trajectories and kinematics.	
6.	Movement programming - Part 3: structured programming ALKCI: B, I, L, O, P, Q	• "container" program (MAIN) and program call • main instructions of the programming language for managing the flow: in particular conditional and cyclic instructions • creation of a "container" program (MAIN) that calls different programs depending on whether or not an event occurs. • creation and call of subroutines • calling of instructions for collision detection	Creating more complex programs through the introduction of structured programming.	20
7.	System Management ALKCI: B, I, L, O, P, Q, R, S	• backup and restore of files and programs (by type, by date, incremental) • system backup and restore • reset of absolute coordinates (Turn-Set) • mechanical calibration of the axes (calibration position and mechanical realignment of the axes) • remote management software from PC	Software and hardware maintenance.	20
8.	Input/Output communication	• elements of theory and transmission of the signal: digital and analog signals, ADC and DAC	Elements of industrial data transmission.	20

	ALKCI: B, I, L, O, P, Q	conversion, analog voltage and current loop transmission • wired Input/Output • BUS digital transmission, field BUS, examples of industrial BUS • control unit internal BUS, assembly and configuration of the BUS coupler, assembly of the Slave and Master interfaces of the field BUS • memory structure and data types • communication ports and mapping • analysis of the connectors and communication cables of the control unit		
9.	Wired I/O configuration and mapping ALKCI: B, I, L, O, P, Q	• the control unit configuration environment • configuration and mapping of digital and analog wired I/O • test of Input and Output signals	Management of digital and analog wired I/O.	10
10.	BUS slave configuration and mapping ALKCI: B, I, L, O, P, Q	• the control unit configuration environment • configuration and mapping of a field BUS Slave module • configuration for remote management of the robotic system • test of Input and Output signals • "container" program (MAIN) implementation and advanced features (see unit 06)	Management of the robotic system by programmable logic controller (PLC).	15
11.	BUS master configuration and mapping ALKCI: B, I, L, O, P, Q	• the control unit configuration environment • design of a master network • external auxiliary configuration software for slave devices • configuration and mapping of a master network • test of Input and Output signals	Management of slave devices by the control unit (for example a gripper).	15

Joint curricula IIOT

module 12

Production Process Development, EQF 4 (3 years)

Level: EQF 4 (3 years)

Time frame: 90 hr

Responsible partner: Šolski center Kranj

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

• basics of computer science and informatics • basics of mechanics	• basics of electrical engineering • basics of microcontroller systems • mathematics	• knowledge of communication technologies • written and oral communication	• knowledge of the transformation of metallic and non-metallic materials

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 12	PRODUCTION PROCESS DEVELOPMENT
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4, 3 YEARS)
TIME FRAME:	90 HOURS

MODULE COMPETENCES:

1. Research of the area/topic
2. Selecting project ideas
3. Preparation of timetable for the project
4. Early product development
5. Prototype testing and evaluation
6. Production of the final project/product
7. Evaluation of the final product

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame (hours)
1.	Research of the area/topic ALKCI: A, B, L, K	• Planning the research • Conducting of research • Preparing a presentation of research results • Presentation of the research	Student: • obtains data on the needs of the industry in the field of automation through online sources	3
2.	Selecting project ideas ALKCI: A, B, F, I, J, K	• Selecting ideas for a project – design thinking method • Development of criteria according to which suitable ideas for the project are selected - use of Business Model Canvas • Choosing the best solution for the project	Student: • searches for different ideas in the field of automation (online resources) • creates a table of project requirements for the needs of automation (Excel) • with the use of design thinking method selects the best solution • tests and develops the idea with Business Model Canvas – through the whole module • selects the appropriate solution according to the research and criteria	6
3.	Preparation of timetable for the project ALKCI: F, H, I, E	• Determining the criteria for the time implementation of the project • Preparation of a schedule for project development	• Calculates the time required for each step of the project (Excel) • Makes a timeline and sequence of activities • Specifies the start time of the prototype • Sets the deadline for project completion	5
4.	Early product development ALKCI: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S	• Preparation of a prototype plan (sketch, list of materials, type of machining procedures ...) • Knowledge how the electronic components and devices operates • Design of technical documentation for the prototype • Use of machine and hand tools for material transformation • Design of the mechanical part of the prototype • Construction of the mechanical part of the prototype • Electronic circuit design • Production of electronic circuit	Student: • considers with safety regulations at work • use appropriate sensors according to the required project criteria • makes an electrical plan using programmes for drawing electrical plans (altium, kicad, easyEda, tinyCad) • binds electronic components according to the electrical	40

		• Connection of electronic sensors and microcontrollers (arduino, rasbery pi) • Prototyping	plan (altium, kicad, easyEda, tinyCad) • makes a list of electronic and mechanical components (BOM, Excel) • makes project components with hand tools (file, saw…) • makes components for project on a CNC machine (turning, milling, drilling), • finally assembles a prototype	
5.	Prototype testing and evaluation ALKCI: F, G, I, E, K, M, O	• Evaluation of the prototype according to the final requirements of the product	Student: • checks the mechanical functioning of the prototype • checks the electronic functioning of the prototype	6
6.	Production of the final project/product ALKCI: A, B, E, F, H, I, J, K, P	• Optimization of component prototypes according to the requirements of the final product • Quality planning and safety of IoT devices • Preparation of a maintenance plan • Electronic / mechatronic control of the device	Student: • optimizes the components of the prototype according to the final requirements of the product • corrects errors in the mechanical functioning of the prototype • corrects errors in the electrical functioning of the prototype • detects deficiencies (incorrect operation in terms of set criteria, power supply errors, signalling, actuators, program operation ...) and errors of the prototype • tests and manages the mechatronic device according to the final requirements of the product • takes care of device / system maintenance according to product requirements	15
7.	Evaluation of the final product ALKCI: E, F, G, I, K, O	• Final product presentation - pitching	Student: • presents the final product in front of the whole class (public presentation of PPT, prezi) - pitch	3
	Visit to the company	• Practical aspect in the company		12

Joint curricula IIOT

module 13

Production Process Development, EQF 4 (4 years)

Level: EQF 4 (4 years)

Time frame: 90 hr

Responsible partner: Šolski center Kranj

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

• basics of computer science and informatics • basics of mechanics	• basics of electrical engineering • basics of microcontroller systems • mathematics	• knowledge of communication technologies • written and oral communication	• knowledge of the transformation of metallic and non-metallic materials

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 13	PRODUCTION PROCESS DEVELOPMENT
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 4, 4 YEARS)
TIME FRAME:	90 HOURS

MODULE COMPETENCES:

1. Research of the area/topic
2. Selecting project ideas
3. Preparation of timetable for the project
4. Early product development
5. Prototype testing and evaluation
6. Production of the final project/product
7. Evaluation of the final product

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame (hours)
1.	Research of the area/topic ALKCI: A, B, L, K	• Planning the research • Conducting of research • Preparing a presentation of research results • Presentation of the research	Student: • obtains data on the needs of the industry in the field of automation through online sources • analyses the obtained data about needs in the field of automation	3
2.	Selecting project ideas ALKCI: A, B, F, I, J, K	• Selecting ideas for a project – design thinking method • Development of criteria according to which suitable ideas for the project are selected - use of Business Model Canvas • Choosing the best solution for the project	Student: • searches for different ideas in the field of automation (online resources) • creates a table of project requirements for the needs of automation (Excel) • with the use of design thinking method selects the best solution • tests and develops the idea with Business Model Canvas – through the whole module • selects the appropriate solution according to the research and criteria	6
3.	Preparation of timetable for the project ALKCI: F, H, I, E	• Determining the criteria for the time implementation of the project • Preparation of a schedule for project development • Preparing a presentation for the course and method of project development • Presentation of the course and method of project preparation	• calculates the time required for each step of the project (Excel) • makes a timeline and sequence of activities • specifies the start time of the prototype • sets the deadline for project completion • makes a presentation about the workflow and methods used during the project (prezi,ppt) • presents the workflow and methods used during the project (prezi,ppt)	5
4.	Early product development ALKCI: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S	• Preparation of a prototype plan (sketch, list of materials, type of machining procedures ...) • Knowledge how the electronic components and devices operates • Design of technical documentation for the prototype • Use of machine and hand tools for material transformation	Student: • draws up a plan for prototype in a software environment for 3D modelling (SolidWorks, Creo, etc.) • makes technical documentation in a software environment for 3D design (SolidWorks, Creo, etc.) • considers with safety regulations at work	40

		• Design of the mechanical part of the prototype • Construction of the mechanical part of the prototype • Electronic circuit design • Production of electronic circuit • Connection of electronic sensors and microcontrollers (arduino, rasbery pi) • Prototyping • Prototype programming	• uses appropriate sensors according to the required project criteria • makes an electrical plan using programmes for drawing electrical plans (altium, kicad, easyEda, tinyCad) • binds electronic components according to the electrical plan (altium, kicad, easyEda, tinyCad) • programs microcontrollers (arduino,rasberry pi, esp32) • uses software tool (visual studio / python ...) for data processing (IOT) • makes a list of electronic and mechanical components (BOM, Excel) • makes project components with hand tools (file, saw…) • makes components for project on a CNC machine (turning, milling, drilling), • finally assembles a prototype • programs the prototype according to the criteria set out in automation	
5.	Prototype testing and evaluation ALKCI: F, G, I, E, K, M, O	• Evaluation of the prototype according to the final requirements of the product • Troubleshooting on the prototype • Retest the prototype	Student: • checks the mechanical functioning of the prototype • checks the electronic functioning of the prototype • checks the software functioning of the prototype • evaluates the performance of the prototype, according to the set criteria • detects deficiencies (incorrect operation in terms of set criteria, power supply errors, signalling, actuators, program operation ...) and errors of the prototype	6
6.	Production of the final project/product ALKCI: A, B, E, F, H, I, J, K, P	a. Optimization of component prototypes according to the requirements of the final product b. Quality planning and safety of IoT devices c. Preparation of a maintenance plan d. Electronic / mechatronic control of the device	Student: • optimizes the components of the prototype according to the final requirements of the product • corrects errors in the mechanical functioning of the prototype • corrects errors in the electrical functioning of the prototype • corrects errors in the software of the prototype • detects deficiencies (incorrect operation in terms of set criteria,	15

		e. Preparation of technical documentation • Preparation of user manual	power supply errors, signalling, actuators, program operation ...) and errors of the prototype • tests and manages the mechatronic device according to the final requirements of the product • takes care of device / system maintenance according to product requirements • creates complete documentation about the product (Microsoft Word) • writes user manual for the product (Microsoft Word)	
7.	Evaluation of the final product ALKCI: E, F, G, I, K, O	• Preparation of the final project report • Making a market presentation of the product • Evaluation of the project development process • Assessment of the possibility for further development of the product • Final product presentation - pitching	Student: • makes an evaluation of the project design, which shows a comparison between the planned and realized situation • creates an interactive market presentation of the product (audio / video; PPT, prezi) - pitch • presents the final product in front of the whole class (public presentation of PPT, prezi) – pitch	3
	Visit to the company	• Practical aspect in the company		12

Joint curricula IIOT

module 14

Production Process Development, EQF 5

Level: EQF 5

Time frame: 250 hr

Responsible partner: Šolski center Kranj

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

- basics of computer science and informatics
- basics of mechanics

- basics of electrical engineering
- basics of microcontroller systems
- mathematics

- knowledge of communication technologies
- written and oral communication

- knowledge of the transformation of metallic and non-metallic materials

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 14	PRODUCTION PROCESS DEVELOPMENT
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 5)
TIME FRAME:	250 HOURS

MODULE COMPETENCES:	
1	Research of the area/topic
2	Selecting project ideas
3	Preparation of timetable for the project
4	Early product development
5	Prototype testing and evaluation
6	Production of the final project/product
7	Evaluation of the final product

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame (hours)
1.	Research of the area/topic ALKCI: A, B, L, K	• Planning the research • Conducting of research • Preparing a presentation of research results • Presentation of the research	Student: • Obtain data on the needs of the industry in the field of automation through online sources • Analyses the obtained data about needs in the field of automation • Evaluates and presents the results of the research to the working group	10
2.	Selecting project ideas ALKCI: A, B, F, I, J, K	• Selecting ideas for a project – design thinking method • Development of criteria according to which suitable ideas for the project are selected - use of Business Model Canvas • Choosing the best solution for the project	Student: • (EQF 3,4,5) Searches for different ideas in the field of automation (online resources) • (EQF 3,4,5) Creates a table of project requirements for the needs of automation (Excel) • (EQF 4,5) With the use of design thinking method selects the best solution • (EQF 5) Testing and development of idea with Business Model Canvas – through the whole module • (EQF 4,5) Selects the appropriate solution according to the research and criteria	20
3.	Preparation of timetable for the project ALKCI: F, H, I, E	• Determining the criteria for the time implementation of the project • Preparation of a schedule for project development • Preparing a presentation for the course and method of project development • Presentation of the course and method of project preparation	• (EQF 4,5) Calculates the time required for each step of the project (Excel) • (EQF 4,5) Makes a timeline and sequence of activities • (EQF 4,5) Specifies the start time of the prototype • (EQF 4,5) Sets the deadline for project completion • (EQF 4,5) Makes a presentation about the workflow and methods used during the project (prezi,ppt) • (EQF 4,5) Presents the workflow and methods used during the project (prezi,ppt)	20
4.	Early product development	• Preparation of a prototype plan (sketch, list of materials, type of machining procedures ...)	Student: • (EQF 4,5) Draws up a plan for prototype in a software environment for 3D modelling (SolidWorks, Creo, etc.)	80

	ALKCI: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S	• Knowledge how the electronic components and devices operates • Design of technical documentation for the prototype • Use of machine and hand tools for material transformation • Design of the mechanical part of the prototype • Construction of the mechanical part of the prototype • Electronic circuit design • Production of electronic circuit • Connection of electronic sensors and microcontrollers (arduino, rasbery pi) • Prototyping • Prototype programming	• (EQF 4,5) Makes technical documentation in a software environment for 3D design (SolidWorks, Creo, etc.) • (EQF 3,4,5) He considers with safety regulations at work • (EQF 3,4,5) Use appropriate sensors according to the required project criteria • (EQF 3,4,5) Makes an electrical plan using programmes for drawing electrical plans (altium, kicad, easyEda, tinyCad) • (EQF 3,4,5) Binds electronic components according to the electrical plan (altium, kicad, easyEda, tinyCad) • (EQF 4,5) programs microcontrollers (arduino,rasberry pi, esp32) • (EQF 4,5) Use software tool (visual studio / python ...) for data processing (IOT) • (EQF 3,4,5) makes a list of electronic and mechanical components (BOM, Excel) • (EQF 3,4) makes project components with hand tools (file, saw…) • (EQF 3,4) makes components for project on a CNC machine (turning, milling, drilling), • (EQF 3,4) finally assembles a prototype • (EQF 4,5) programs the prototype according to the criteria set out in automation	
5.	Prototype testing and evaluation ALKCI: F, G, I, E, K, M, O	• Evaluation of the prototype according to the final requirements of the product • Troubleshooting on the prototype • Retest the prototype	Student: • (EQF 3,4) checks the mechanical functioning of the prototype • (EQF 3,4) checks the electronic functioning of the prototype • (EQF 4,5) checks the software functioning of the prototype • (EQF 4,5) evaluates the performance of the prototype, according to the set criteria • (EQF 4,5) detects deficiencies (incorrect operation in terms of set criteria, power supply errors, signalling, actuators, program operation ...) and errors of the prototype	20

6.	Production of the final project/product ALKCI: A, B, E, F, H, I, J, K, P	a. Optimization of component prototypes according to the requirements of the final product b. Knowledge of IEC / ISO standards c. Quality planning and safety of IoT devices d. Preparation of a maintenance plan e. Electronic / mechatronic control of the device f. Preparation of technical documentation • Preparation of user manual	Student: • (EQF 3,4) Optimizes the components of the prototype according to the final requirements of the product • (EQF 3,4) Corrects errors in the mechanical functioning of the prototype • (EQF 3,4,5) Corrects errors in the electrical functioning of the prototype • (EQF 4,5) corrects errors in the software of the prototype • (EQF 3,4,5) detects deficiencies (incorrect operation in terms of set criteria, power supply errors, signalling, actuators, program operation ...) and errors of the prototype • (EQF 5) adapts the product to the requirements of IEC / ISO standards and eliminates deficiencies • (EQF 3,4,5) tests and manages the mechatronic • device according to the final requirements of the product • (EQF 3) takes care of device / system maintenance according to product requirements • (EQF 4,5) creates complete documentation about the product (Microsoft Word) • (EQF 4,5) writes user manual for the product (Microsoft Word)	30
7.	Evaluation of the final product ALKCI: E, F, G, I, K, O	• Preparation of the final project report • Making a market presentation of the product • Evaluation of the project development process • Assessment of the possibility for further development of the product • Final product presentation - pitching	Student: • (EQF 4,5) makes an evaluation of the project design, which shows a comparison between the planned and realized situation • (EQF 5) explores the possibilities of further product development with the help of online resources • (EQF 4,5) creates an interactive market presentation of the product (audio / video; PPT, prezi) - pitch • (EQF 3,4,5) presents the final product in front of the whole class (public presentation of PPT, prezi) – pitch	30
	Visit to the company	• Practical aspect in the company		40

Joint curricula IIOT

module 15

Data Science, EQF 4 (3 YEARS)

EQF 4 (3 YEARS)

Time frame: 112 hr

Responsible partner: Šolski center Kranj

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

• basics in programming, • basics in EXCEL, • basics in SQL	• mathematics: basics of statistics	• basics of electrical engineering and microcontrollers	• communication skills (written and oral) • foreign language skills

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 15	DATA SCIENCE
LEVEL OF DIFFICULTY:	EQF 4, 3 YEARS
TIME FRAME:	112 HOURS

MODULE COMPETENCES:

1. Analyzing of the selected problem
2. Data acquisition (IOP)
3. Preprocessing / cleaning of raw data into databases / tables (Excel, Orange, Pandas, SQLite, SQLAlchemy)
4. Data visualization (Excel)
5. Selection and design of models / algorithms
6. Model testing on peripheral cases and accuracy assessment (system evaluation)
7. System optimization
8. Documenting the capabilities and properties of the system
9. Independent project

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Analyzing of the selected problem ALKCI: A, B, L, J	Analysis of the project from as many different views (angles) as possible Planning upcoming steps and possible complications Examples: • Decision system for watering, lighting,… plants, • occupancy counting: parking spaces, rooms,… • home automation (curtains, heating, lighting, ..), • problem notification system (flood, device failure, ..), • inventory management system, • work control system	Student: • creates the context of the problem • identifies problem points and possible solutions • "brainstorms" solution to the problem • prepares solution implementation plan	Theory + practice 4 hours
2.	Data acquisition (IOP) ALKCI: A, B, G, J	• Data type theory • Production of IOT sensors (connection of sensors, relays, switches,…) [electro part] • Programming of microcontrollers for data acquisition [computer part] • System data connection to a single point - HUB (RPi) • Data storage for later processing in HUB or immediate use (live)	Student: • distinguishes between different types of data • identifies the necessary equipment (microcontrollers, sensors, switches…) • sets up a data acquisition system using sensors connected to a wireless microcontroller (later IOT sensor) (ESP32, Wemos d1, ESP8266, Raspberry Pi,…) • connects data from IOT sensors (Bluetooth, Wi-Fi, Narrowband,…) • programmes the IOT sensor according to the selected microcontroller (RPi - Python,	Theory: 4 hours Practice: 12 hours

			• ESP32, Wemos - arduino ompatible) to transfer the desired data • In the case of further processing of raw data; raw data is saved form suitable for later processing (in a text file (JSON, .txt, .csv,…)	
3.	Preprocessing / cleaning of raw data into databases / tables (Excel, Orange, Pandas, SQLite, SQLAlchemy) ALKCI: F, H, J	• Basics of searching existing databases • Purification of data into a usable format • Defining the structure of the final data • Selection of a database for later query Reccomentadion: In the case of fast live data flow, processing should take place on the server (via a socket, ie. Flask-SocketIO)	Student: • cleans the raw data into a format suitable for later use (Excel) The complexity of the logical structure of the database grows with the EQF scale.	Theory: 2 hours Practice: 12 hours
4.	Data visualization (Excel) ALKCI: E, I, J	• Choice of visualization appropriate for the data • Production of graphs, visual presentation of data • Search for patterns, irregularities, points of interest,… in the data	Student: • decides for the appropriate visualization of data (they can be discrete, sequential, numerical, alpha-numerical, audio) • visualizes data according to chosen type of visualisation (Excel, Processing)	Theory + practice 6 hours
5.	Selection and design of models/algorithms ALKCI: E, F, H, I, J	• Choice of algorithms / models • Programming of data reception facilities • Implementation of algorithms on data • * Implementation of artificial intelligence algorithms on data • Programming the HUB to respond to commands from connected micro-controllers • Sending commands to the HUB from the server (turning switches, motors, relays on / off, changing system settings) * HUB, server and database can be on the same system (same RPi) ** step depends on the problem	Student: • importing data into the selected server environment for processing (say Python - Flask) * • structuring objects for local data storage (if the database is not local) • extracts all necessary input data from the data • use of simple algorithms (min, max, averages, deviations, branches,…) for data processing and definition of output data (based on input) • sending decisions / changes back to HUB • (for example: turn off the light, open the valve, change the system clock,…) **	Theory: 4 hours Practice: 25 hours

			• Set the HUB to execute all server commands	
6.	Model testing on peripheral cases and accuracy assessment (system evaluation) ALKCI: E, F, H, I, M	• Model verification in cases not covered by the program logic • Resolving unresolved cases • Evaluation of the system operation (according to the control test, previous-annual statistics, before optimization) • Search for weak parts and correction to increase the autonomy of the system (search for the least reliable parts of the system)	Student: • Finds problematic (test) cases • Finds out malfunctions with the help of test cases • Corrects the irregularities	Theory + practice 4 hours
7.	System optimization ALKCI: E, F, G, H, I, M	• Search for holes and not optimized parts in the system • The impact of optimization on the final system • Calculate improvements after optimization * differs from problem to problem	Student: • finds non-optimized parts (example: in case of code Big O notation) • search for the parameters that have the strongest effect on the system • adjusts model parameters for better efficiency (by trying, mathematics, genetic algorithms,…) • calculates improvements after adjustments • knows when to finish with improvements (overfitting in case of machine learning)	Theory + practice 4 hours
8.	Documenting the capabilities and properties of the system ALKCI: H, M, J, K	• User instructions • Documentation about manufacturing process and model functions	Student: Defines system functions • Defines the input and output data of the system • Define the components of the system • Creates user instructions (for the end user)	Practice: 4 hours + independent work

			• Creates documentation (for the purposes of reproduction - open source) Markdown, Latex	
	Independent project ALKCI: A, B, C, D, E, F, G, H, I, J, L, M, N, O, P, Q, R, S	• Students choose a project and create it according to the steps and knowledge gained from before. • The project can be given by mentor, company, chosen by the student,… (with the approval of the mentor) • The criteria are determined according to the complexity of the project, the originality of the project, the implementation of the project, the usability,…	Student: • selects the project and starts with the first step (analysis) • through the process described in curriculum identifies the necessary work for the selected project • planns the project – gannt chart • implements the project	Under the guidance of mentors: 30 hours

Joint curricula IIOT

module 16

Data Science, EQF 4 (4 YEARS)

EQF 4 (4 YEARS)

Time frame: 112 hr

Responsible partner: Šolski center Kranj

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

• basics in programming, • basics in EXCEL, • basics in SQL	• mathematics: basics of statistics	• basics of electrical engineering and microcontrollers	• communication skills (written and oral) • foreign language skills

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 16	DATA SCIENCE
LEVEL OF DIFFICULTY:	EQF 4, 4 YEARS
TIME FRAME:	112 HOURS

COMPETENCE:

1. Analyzing of the selected problem
2. Data acquisition (IOP)
3. Preprocessing / cleaning of raw data into databases / tables (Excel, Orange, Pandas, SQLite, SQLAlchemy)
4. Data visualization (Excel)
5. Selection and design of models / algorithms
6. Model testing on peripheral cases and accuracy assessment (system evaluation)
7. System optimization
8. Documenting the capabilities and properties of the system
9. Independent project

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Analyzing of the selected problem ALKCI: A, B, L, J	Analysis of the project from as many different views (angles) as possible Planning upcoming steps and possible complications Examples: • Decision system for watering, lighting,… plants, • occupancy counting: parking spaces, rooms,… • home automation (curtains, heating, lighting, ..), • problem notification system (flood, device failure, ..), • inventory management system, • work control system	Student: • creates the context of the problem • identifies problem points and possible solutions • "brainstorms" solution to the problem • prepares solution implementation plan	Theory + practice 4 hours
2.	Data acquisition (IOP) ALKCI: A, B, G, J	• Data type theory • Production of IOT sensors (connection of sensors, relays, switches,…) [electro part] • Programming of microcontrollers for data acquisition [computer part] • System data connection to a single point - HUB (RPi) • Data storage for later processing in HUB or immediate use (live)	• Student: • distinguishes between different types of data • identifies the necessary equipment (microcontrollers, sensors, switches…) • sets up a data acquisition system using sensors connected to a wireless microcontroller (later IOT sensor) (ESP32, Wemos d1, ESP8266, Raspberry Pi,…) • connects data from IOT sensors (Bluetooth, Wi-Fi, Narrowband,…) • programmes the IOT sensor according to the selected microcontroller (RPi - Python, • ESP32, Wemos - arduino ompatible) to transfer the desired data • In the case of further processing of raw data; raw data is saved form suitable for later processing (in a text file (JSON, .txt, .csv,…)) • In the case of live data processing; data is transfered directly trough "socket" on server (any server, in a Python environment such as Flask)	Theory: 4 hours Practice: 12 hours

3.	Preprocessing / cleaning of raw data into databases / tables (Excel, Orange, Pandas, SQLite, SQLAlchemy) ALKCI: F, H, J	• Basics of searching existing databases • Purification of data into a usable format • Defining the structure of the final data • Selection of a database for later query Reccomentadion: In the case of fast live data flow, processing should take place on the server (via a socket, ie. Flask-SocketIO)	Student: • cleans the raw data into a format suitable for later use (Excel) • cleans the raw data into a format suitable for later use (Orange) The complexity of the logical structure of the database grows with the EQF scale.	Theory: 2 hours Practice: 12 hours
4.	Data visualization (Excel) ALKCI: E, I, J	• Choice of visualization appropriate for the data • Production of graphs, visual presentation of data • Search for patterns, irregularities, points of interest,… in the data	Student: • decides for the appropriate visualization of data (they can be discrete, sequential, numerical, alpha-numerical, audio) • visualizes data according to chosen type of visualisation (Excel, Processing)	Theory + practice 8 hours
5.	Selection and design of models/algorithms ALKCI: E, F, H, I, J	• Choice of algorithms / models • Programming of data reception facilities • Implementation of algorithms on data • * Implementation of artificial intelligence algorithms on data • Programming the HUB to respond to commands from connected micro-controllers • Sending commands to the HUB from the server (turning switches, motors, relays on / off, changing system settings) * HUB, server and database can be on the same system (same RPi) ** step depends on the problem	Student: • importing data into the selected server environment for processing (say Python - Flask) * • structuring objects for local data storage (if the database is not local) • extracts all necessary input data from the data • use of simple algorithms (min, max, averages, deviations, branches,…) for data processing and definition of output data (based on input) • sending decisions / changes back to HUB • (for example: turn off the light, open the valve, change the system clock,…) **	Theory: 4 hours Practice: 25 hours

			• Set the HUB to execute all server commands	
6	Model testing on peripheral cases and accuracy assessment (system evaluation) ALKCI: E, F, H, I, M	• Model verification in cases not covered by the program logic • Resolving unresolved cases • Evaluation of the system operation (according to the control test, previous-annual statistics, before optimization) • Search for weak parts and correction to increase the autonomy of the system (search for the least reliable parts of the system)	Student: • finds problematic (test) cases • finds out malfunctions with the help of test cases • corrects the irregularities	Theory + practice 4 hours
7.	System optimization ALKCI: E, F, G, H, I, M	• Search for holes and not optimized parts in the system • The impact of optimization on the final system • Calculate improvements after optimization * differs from problem to problem	Student: • finds non-optimized parts (example: in case of code Big O notation) • search for the parameters that have the strongest effect on the system • adjusts model parameters for better efficiency (by trying, mathematics, genetic algorithms,…) • calculates improvements after adjustments • knows when to finish with improvements (overfitting in case of machine learning)	Theory + practice 4 hours
8.	Documenting the capabilities and properties of the system ALKCI: H, M, J, K	• User instructions • Documentation about manufacturing process and model functions	Student: • defines system functions • defines the input and output data of the system • define the components of the system • creates user instructions (for the end user) • creates documentation (for the purposes of reproduction - open source) Markdown, Latex	Practice: 4 hours + independent work

9.	Independent project ALKCI: A, B, C, D, E, F, G, H, I, J, L, M, N, O, P, Q, R, S	• Students choose a project and create it according to the steps and knowledge gained from before. • The project can be given by mentor, company, chosen by the student,… (with the approval of the mentor) • The criteria are determined according to the complexity of the project, the originality of the project, the implementation of the project, the usability,…	Student: • selects the project and starts with the first step (analysis) • through the process described in curriculum identifies the necessary work for the selected project • planns the project – gannt chart • implements the project	Under the guidance of mentors: 30 hours

Joint curricula IIOT

module 17

Data Science, EQF 5

Level: EQF 5

Time frame: 112 hr

Responsible partner: Šolski center Kranj

Field Specific IIOT Studies (each Partner prepares field specific IIOT orientation training for the module)

• basics in programming, • basics in EXCEL, • basics in SQL	• mathematics: basics of statistics	• basics of electrical engineering and microcontrollers	• communication skills (written and oral) • foreign language skills

Prerequisites (what student has to master before attending)
(prepared with collaboration with Industry)

MODULE 17	DATA SCIENCE
LEVEL OF DIFFICULTY:	LEVEL IV (EQF 5)
TIME FRAME:	112 HOURS

MODULE COMPETENCES:

1. Analyzing of the selected problem
2. Data acquisition (IOP)
3. Preprocessing / cleaning of raw data into databases / tables (Excel, Orange, Pandas, SQLite, SQLAlchemy)
4. Data visualization (Excel)
5. Selection and design of models / algorithms
6. Model testing on peripheral cases and accuracy assessment (system evaluation)
7. System optimization
8. Documenting the capabilities and properties of the system
9. Independent project

Nr.	Competence	Professional skills (built in meta & green skills)	Learning outcomes	Time frame
1.	Analyzing of the selected problem ALKCI: A, B, L, J	Analysis of the project from as many different views (angles) as possible Planning upcoming steps and possible complications Examples: • Decision system for watering, lighting,… plants, • occupancy counting: parking spaces, rooms,… • home automation (curtains, heating, lighting, ..), • problem notification system (flood, device failure, ..), • inventory management system, • work control system	Student: • creates the context of the problem • identifies problem points and possible solutions • "brainstorms" solution to the problem • prepares solution implementation plan • searches for possible problems and bottlenecks of the system	Theory + practice 4 hours
2.	Data acquisition (IOP) ALKCI: A, B, G, J	• Data type theory • Production of IOT sensors (connection of sensors, relays, switches,…) [electro part] • Programming of microcontrollers for data acquisition [computer part] • System data connection to a single point - HUB (RPi) • Data storage for later processing in HUB or immediate use (live)	Student: • distinguishes between different types of data • identifies the necessary equipment (microcontrollers, sensors, switches…) • sets up a data acquisition system using sensors connected to a wireless microcontroller (later IOT sensor) (ESP32, Wemos d1, ESP8266, Raspberry Pi,…) • connects data from IOT sensors (Bluetooth, Wi-Fi, Narrowband,…) • programmes the IOT sensor according to the selected microcontroller (RPi - Python, • ESP32, Wemos - arduino ompatible) to transfer the desired data • In the case of further processing of raw data; raw data is saved form suitable for later processing (in a text file (JSON, .txt, .csv,…)) • In the case of live data processing; data is transfered directly trough "socket" on server (any server, in a Python environment such as Flask) • in the case of connection to already existing devices (OBD2, ..); interface development (electrical and programmable part – on microcontroller) between the existing system and the server	Theory: 4 hours Practice: 12 hours

3.	Preprocessing / cleaning of raw data into databases / tables (Excel, Orange, Pandas, SQLite, SQLAlchemy) ALKCI: F, H, J	• Basics of searching existing databases • Purification of data into a usable format • Defining the structure of the final data • Selection of a database for later query Reccomentadion: In the case of fast live data flow, processing should take place on the server (via a socket, ie. Flask-SocketIO)	Student: • cleans the raw data into a format suitable for later use (Excel) • cleans the raw data into a format suitable for later use (Orange) • cleans the raw data into a format suitable for later use (Pandas) • processes problematic data (blank data, duplicates, data reduction • selects the data storage structure (SQLite „ SQLAlchemy,…) • prepares the database and save the data in a suitable format for query. • Performes query by database The complexity of the logical structure of the database grows with the EQF scale.	Theory: 2 hours Practice: 12 hours
4.	Data visualization (Excel) ALKCI: E, I, J	• Choice of visualization appropriate for the data • Production of graphs, visual presentation of data • Search for patterns, irregularities, points of interest,… in the data	Student: • decides for the appropriate visualization of data (they can be discrete, sequential, numerical, alpha-numerical, audio) • visualizes data according to chosen type of visualisation (Excel, Processing) • deepens the insight into data according to the results of visualization (data analysis)	Theory + practice 12 hours
5.	Selection and design of models/algorithms ALKCI: E, F, H, I, J	• Choice of algorithms / models • Programming of data reception facilities • Implementation of algorithms on data • * Implementation of artificial intelligence algorithms on data • Programming the HUB to respond to commands from connected micro-controllers • Sending commands to the HUB from the server (turning switches, motors, relays on / off, changing system settings)	Student: • importing data into the selected server environment for processing (say Python - Flask) * • structuring objects for local data storage (if the database is not local) • extracts all necessary input data from the data • use of simple algorithms (min, max, averages, deviations, branches,…) for data processing and definition of output data (based on input) • sending decisions / changes back to HUB	Theory: 4 hours Practice: 25 hours

		* HUB, server and database can be on the same system (same RPi) ** step depends on the problem	• (for example: turn off the light, open the valve, change the system clock,…) ** • Set the HUB to execute all server commands • extracts new features from the data • uses algorithms (artificial intelligence) for data processing and definition of output data (based on input) •	
6.	Model testing on peripheral cases and accuracy assessment (system evaluation) ALKCI: E, F, H, I, M	• Model verification in cases not covered by the program logic • Resolving unresolved cases • Evaluation of the system operation (according to the control test, previous-annual statistics, before optimization) • Search for weak parts and correction to increase the autonomy of the system (search for the least reliable parts of the system)	Student: • Finds problematic (test) cases • Finds out malfunctions with the help of test cases • Corrects the irregularities • Tries to increase resilience (system autonomy)	Theory + practice 4 hours
7.	System optimization ALKCI: E, F, G, H, I, M	• Search for holes and not optimized parts in the system • The impact of optimization on the final system • Calculate improvements after optimization * differs from problem to problem	Student: • finds non-optimized parts (example: in case of code Big O notation) • search for the parameters that have the strongest effect on the system • adjusts model parameters for better efficiency (by trying, mathematics, genetic algorithms,…) • calculates improvements after adjustments • knows when to finish with improvements (overfitting in case of machine learning)	Theory + practice 4 hours
8.	Documenting the capabilities and properties of the system ALKCI: H, M, J, K	• User instructions • Documentation about manufacturing process and model functions	Student: Defines system functions • Defines the input and output data of the system • Define the components of the system • Creates user instructions (for the end user) • Creates documentation (for the purposes of reproduction - open source) Markdown, Latex	Practice: 4 hours + independent work

9.	Independent project ALKCI: A, B, C, D, E, F, G, H, I, J, L, M, N, O, P, Q, R, S	• Students choose a project and create it according to the steps and knowledge gained from before. • The project can be given by mentor, company, chosen by the student,… (with the approval of the mentor) • The criteria are determined according to the complexity of the project, the originality of the project, the implementation of the project, the usability,…	Student: • selects the project and starts with the first step (analysis) • through the process described in curriculum identifies the necessary work for the selected project • planns the project – gannt chart • implements the project	Under the guidance of mentors: 30 hours

Companies involved in developing the joint curricula:

Organization	Module	EQF level	Companies
Šolski center Nova Gorica	Artificial Intelligence	4,5	U Blox S.p.A., Kolektor Group Slovenia, Domel d.o.o., Mahle EDS d.o.o., Marken Ltd., RLS d.o.o., GEN-I d.o.o., Yaskava Slovenia d.o.o.
Šolski center Nova Gorica	Cyber Security	4,5	U Blox S.p.A., Kolektor Group Slovenia, Domel d.o.o., Mahle EDS d.o.o., Marken Ltd., RLS d.o.o., GEN-I d.o.o., Yaskava Slovenia d.o.o.
SATAEDU	Robotics Engeneering	4	Riffid, Cimcorp, Beckhoff, VSP (Vakka-Suomen Puhelin), Sermatech, Prizztech Winnova, ADE, Pintos, UTU Oy, Luvata, Rippertech, Dyme Solutions, Harju Electer (Satmatic)
Šolski center Velenje	Robotics Engeneering	4	MEGA M d.o.o., MIEL elektronika d.o.o. AUTOTECH d.o.o., mCost d.o.o.
I.S.I.S. A. Malignani	Robotics Engeneering	5	Sorint SpA, Comau SpA
Šolski center Kranj	Production Process Development	4,5	Polycom Škofja Loka d.o.o. , Iskraemeco d.d., Iskra EVS, Hennlich d.o.o., Skupina Domel, Chemets d.o.o.
Šolski center Kranj	Data Science	4,5	Polycom Škofja Loka d.o.o. , Iskraemeco d.d., Iskra EVS, Hennlich d.o.o., Skupina Domel, Chemets d.o.o.
Tallinn Polytechnic	AR	5	Technical University Innovation Center Mektory

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