INTERNET OF THINGS FOR EUROPEAN SMALL AND MEDIUM ENTERPRISES

Erasmus+

IoT4SMEs

INTERNET OF THINGS FOR EUROPEAN SMALL AND MEDIUM ENTERPRISES

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IoT4SMEs Qualifications
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October 2017	Final version of full description of the IoT4SMEs qualifications.

Contents

1. IoT4SMEs Qualifications

The IoT4SMEs project[1] aims to pursue the national and European policies on Internet of Things, the general objectives of the Digital Single Market strategy and of the Alliance for the Internet of Things Innovation, with the general objective of qualifying new professionals able to support the digital transformation of the European companies exploiting to the advantages offered by the IoT technology.. This is achieved by raising awareness of the potentialities of the IoT and by training and qualifying professionals able to use these technologies.

Therefore, a specific objective of the IoT4SMEs project is to create "*creating VET qualifications for professionals inside European Companies, enhancing their digital competences and training them to introduce and manage IoT technologies and applications*". The qualifications are designed according to the European lifelong learning instruments (EQF[2], ECVET[3] and EQAVET[4]), in order to ensure the recognition at European level and the transferability of the qualification units.

The Intellectual Output 2 of the project includes the design of the qualifications, of the validation methodologies and of the accumulation and transfer instruments.

In particular, this document describes the design of the IoT4SMEs Qualifications in terms of contexts, contents, didactic units, pre-requisites and minimum suggested EQF. This document is the basis for the detailed description of the IoT4SMEs Qualifications in terms of Learning Outcomes.

[1] http://www.iot4smes.eu/

[2] https://ec.europa.eu/ploteus/documentation#documentation_76

[3] http://www.ecvet-team.eu/

[4] http://www.eqavet.eu/gns/home.aspx

2. Methodology

In order to approach to design of the qualifications, the IoT4SMEs partnership has taken into account:

- the analysis of the survey carried out at European level by the partnership in the Intellectual Output 1, described in the IoT4SMEs report “Analysis of the training needs and professional skills analysis”;
- the analysis of the state of art of IoT technologies and application at European level, carried out by the partnership in the Intellectual Output 1, described in the IoT4SMEs report “State of art of IoT at European level”;
- existing national and international studies, surveys and reports on the use of IoT technologies and applicarions, on the impact on the business sector and on the foreseen potentialities;
- the project proposal, the declared objectives and target groups.

As results of these studies, the partnership has identifies three main target sectors:

- - in the SME sector: managers, professionals and technicians, SME associations, business networks at regional, national and European level;
- - in the professions sector: IoT developers, IoT users, IoT experts, IT sector consultants in general, networks and professional associations;
- - in the education sector: higher education institutions, associations of higher education institutions, academics, students and student associations especially in technical subjects.

In addition, we will consider incubators, chambers of commerce, and training agencies.

For this reason, four valuable qualifications have been identified:

- IoT Decision Maker: it is a basic qualification for all the operators in the business sector that intend to deal with IoT technologies and applications. It provides the basics of IoT and an entry-level knowledge of the main applications for business. The certified professional, even without advanced ICT competences and skills, is able to understand the most common IoT applications and their uses, is able to evaluate their utility for the company and their cost-effectiveness, as well as the potential risks and concerns.
- IoT Microcontroller Developer: it is an advanced qualification for professionals that intend to design and develop IoT applications based on microcontrollers. It provides competences on architecture and programming of microcontrollers, on networking and security. The certified operator is able work in or for companies that intend to develop or adopt IoT solutions, evaluating their utility and their cost-effectiveness and taking part to the design and implementation process.
- IoT Microprocessor Developer: it is an advanced qualification for professionals that intend to design and develop IoT applications based on microprocessors. It provides competences on architecture and programming of microprocessors, on networking and security. The certified operator is able work in or for companies that intend to develop or adopt IoT solutions, evaluating their utility and their cost-effectiveness and taking part to the design and implementation process.
- IoT Data Analyst: it is an advanced qualification for professionals that intend to deal with IoT applications, with specific reference to the post-processing and data analysis tasks. It provides competences on the most common data analysis methodologies, on IoT infrastructures and platforms, on networking and security. The certified operator is able work in or for companies that intend to adopt IoT solutions, exploiting the data gathered from these applications.

A short version of the qualifications' description, agreed among partners, has been defined previously.

In the following sections, after minor modifications, a complete version of each qualification is provided in terms of sectors of applications, contents, didactic units, performance description, key activities and related learning outcomes (Knowledge, Skills and Competences).

3. QUALIFICATION TITLE: IoT for Decision Maker

Title	**IoT Decision Maker**
Label	
EQF/NQF LEVEL (Recommended)	**EQF/NQF LEVEL 4**

CORE UNITS OF LEARNING OUTCOMES	ECVET POINTS
Unit 1 Introduction to IoT Technology	0,75
Unit 2 IoT business strategy	0,75
Unit 3 Overview of data analysis	1,00
Unit 4 Legal aspects	0,75
Unit 5 Basics of networking and security	0,75
TOTAL ECVET POINTS	**4,00**

Update requirements for the overall qualification: **every year**
(CPD – Continuous Professional Development)

Qualification update: **every 2 years**

***ECVET POINTS**:

1 point = 25 hours of workload

	Unit 1 of Learning Outcomes: **Introduction to IoT Technology**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Define basic terms and principles in IoT Describe the main applications in different sectors Analyse components and services related to hardware and software adopted Describe and analyse characteristics, advantages and challenges of IoT communication technologies and platform Analyse and demonstrate the main commonalities and differences between IoT and other technologies Identify and describe the main national and international policies in the IoT field with focus on European policies
	Key performance indicators: Identify and set-up IoT hardware and software Demonstrate comprehensive knowledge of IoT technologies
	Behaviours underpinning effective performance: Be impartial in illustrating benefits and risks regarding the application of IoT

TOTAL ECVET POINTS: 0,75			
Key activities:	**Knowledge**	**Skills**	**Competencies**
Define basic terms and principles in IoT	Has factual and theoretical knowledge on the following topics: 1. Internet of Things terminology and underlying engineering technologies 2. Technological trends which have led to IoT 3. Embedded systems in terms of interface 4. Impact of IoT on organizations/society.	Illustrate the contents and the interactions between specific concepts related to IoT Describe IoT characteristics and models showing the possible impact of IoT services on organizations' development Demonstrate necessary knowledge in underlying technologies, s.a. computer science	Take responsibility, within regulatory requirements, to implement generic characteristics of IoT

Describe and analyse characteristics, advantages and challenges of IoT communication technologies and platforms	Has factual and theoretical knowledge on the following topics: 1. main application sectors of IoT 2. hardware and software most commonly used in IoT devices	Analyse characteristics and implement different roles of the IoT users in different sectors Has the ability to identify the most common adopted hardware and software for IoT devices	Supervise the routine work of the personnel for ensuring the efficient accomplishment of the specific role attributed Demonstrate autonomy in recognizing the most common adopted IoT technologies
Analyse components and services related to hardware and software adopted	Has factual and theoretical knowledge on the following topics: 1. IoT protocols 2. IoT communication technologies 3. IoT communication protocols and platforms	Analyse and explain the different benefits and challenges of IoT technologies and communication platforms Put into practice methods for implementing IoT protocols.	Take responsibility, within regulatory requirements, to identify the type of IoT technologies needed within the organization Based on internal standards and requirements, support the implementation of IoT protocols
Analyse and demonstrate the main commonalities and differences between IoT and other ICT technologies	Has factual and theoretical knowledge on the following topics: 1. Cloud computing 2. Big Data 3. Industry 4.0	Analyse and describe specific characteristics of the different ICT technologies	Capable to demonstrate the strong and weak characteristics of the different ICT technologies
Identify and describe the main national and international policies	Is aware of the main different policies at national and international level, supporting the diffusion of IoT.	Support the European SMEs in implementing innovative IoT technologies respecting national and international provisions.	Take the responsibility, within internal regulatory framework, to advice appropriate action for the implementation of IoT technologies

	Unit 2 of Learning Outcomes: **IoT business strategy**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Describe and analyse characteristics and opportunities of new products and services deriving from internet connectivity in terms of setting up new related businesses Analyse and describe features of IoT business solutions

	Identify and describe the main challenges and opportunities posed by introducing the IoT into a business Describe how to create an IoT business
	Key performance indicators: Implementation of an IoT business.
	Behaviours underpinning effective performance: Demonstrate a fair and ethical behaviour in tackling business' challenges when introducing IoT technologies

TOTAL ECVET POINTS: 0,75			
Key activities:	**Knowledge**	**Skills**	**Competences**
Describe and analyse characteristics and opportunities of new products and services deriving from internet connectivity in terms of setting up new related businesses	Has factual and theoretical knowledge on the following topics: - Features of products and services internet connected - Benefits and challenges of the Internet of Things - Methods to measure the customers' satisfaction - New IoT-business opportunities - oT business case	Analyse and assess characteristics of IoT applied to products and services Analyse and explain the different benefits and challenges of connected products and services Provide and put in practice methods to develop new IoT-business opportunities Is able to identify good practices in the field of IoT technologies for SMEs, based on specific quality criteria Demonstrate and evaluate the opportunities that IoT could bring in the customers' satisfaction and customers' services fields	Take the responsibility to propose customized IoT solutions to SMEs, according to their needs and types of services they offer Take the responsibility, within internal regulatory framework, to support the assessment of IoT-business opportunities Demonstrate autonomy in analysing and selecting the most relevant showcases in the field of IoT technologies for European SMEs
Analyse and describe features of IoT business solutions	Has factual and theoretical knowledge on the following topics: - New product features - Better services - New products offerings - Business opportunities and competitive risks of IoT	Analyse and describe IoT in terms of new products features, new products offerings and better services for IoT users Is able to setup related business cases Is able to identify competitive risks and opportunities of IoT	Demonstrate autonomy in monitoring and identifying the potential impact of IoT on business Take responsibility to advice on appropriate IoT business solutions based on revenues and costs analysis

	- Creation of a successful IoT business for SMEs - IoT technologies in the market - Revenues and costs	from the business perspective Analyse and explain changes deriving from operational improvements and resulting from IoT technologies in the market	
Identify and describe the main challenges posed by introducing the IoT into a business	Has factual and theoretical knowledge on the following topics: - Strategy and alignment - Organization - Budgeting - Product development - Manufacturing - Distribution - Customer satisfaction - IoT solution	Analyse and explain the challenges posed by the introduction of IoT into a business Put into practice methods for implementing business strategies using IoT to achieve objectives	Take responsibility, within internal regulatory framework, to provide advice to SMEs to include IoT technologies into their business Take responsibility, within regulatory requirements, to identify relevant strategies
Describe how to create an IoT business	Has factual and theoretical knowledge on the following topics: - Organizational, management, financial resources - IoT offering - Skills and resources required for an IoT business	Interpret and illustrate the main organizational, management and financial principles to implement IoT technologies into business Analyse and illustrate the new IoT offering and support the IoT technologies implementation in line with the organization's context Is able to analyse and select skills and resources needed to successfully create an IoT business Capability of allocating related financial resources and setting up a proper business plan	Take responsibility, within the regulatory requirements, to advice on the type of IoT technologies needed within the organization Demonstrate autonomy in monitoring and evaluating the implementation of skills and resources required to develop IoT business

	Unit 3 of Learning Outcomes**: Overview of data analysis**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Define basic concepts of and terminology of IoT data analysis Describe data generation, analysis and usage from IoT systems Define and put into practice methods and tools for implement IoT infrastructure Illustrate and analyse characteristics, advantages and challenges related to data analysis techniques Explain the role of big data, cloud computing and data analytics in a typical IoT system
	Key performance indicators: Supervise the appropriate implementation of IoT-system architecture
	Behaviours underpinning effective performance: Accuracy and precision in selecting relevant case studies regarding analytics in IoT environments Monitor appropriate understanding of the different role of big data, cloud computing, data analytics in a typical IoT system

TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Define basic concepts of and terminology of IoT data analysis	Has factual and theoretical knowledge of IoT data analysis	Illustrate the main characteristics of data analysis in IoT environments	Take responsibility, within regulatory requirements, to implement generic characteristics of data analysis
Describe data generation, analysis and usage from IoT systems	Has factual and theoretical knowledge of the IoT ecosystem for data acquisition, filtering, transmission and analysis	Analyse and illustrate the contents of specific concepts related to IoT management and analytics Identify and describe case studies on analytics applied to IoT scenarios	Demonstrate autonomy in analysing and selecting the most relevant case studies in the field of analytics for IoT environments

Define and put into practice methods and tools for the implementation of IoT infrastructure	Has factual and theoretical knowledge on the following topics: - Architecture of IoT-system: SOA and other approach - Data processing approach: batch vs stream - Opportunities for predictive analytics	Describe and support the implementation of software designing approaches (e.g. SOA) Analyse and illustrate the differences and commonalities between batch and stream approaches in data processing	Demonstrate autonomy in implementing IoT-system architecture
Illustrate and analyse characteristics, advantages and challenges related to data analysis techniques	Has factual and theoretical knowledge on the following topics: - Pattern recognition - Data-mining - AI-methods - Predictive analytics	Analyse and support the implementation of data analysis techniques	Supervise the routine work of the personnel for ensuring the efficient implementation and monitoring of data analysis techniques within the organization Demonstrate autonomy in identifying appropriate data-mining techniques
Explain the role of big data, cloud computing and data analytics in a typical IoT system	Has factual and theoretical knowledge on the following topics: - Big data - Data analytics - Cloud and Fog computing (data processing approach) - Industrial example	Analyse and describe the differences and commonalities between big data, cloud computing and data analytics in IoT systems and the innovation, opportunities and challenges the bring	Take the responsibility, within regulatory requirements, to identify the role of big data, cloud computing and data analytics needed within the organization

	Unit 4 of Learning Outcomes**: Legal aspects**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Illustrate and implement legal requirements related to IoT Describe and put into practice methods and tools for personal data management in line with national and international provisions Apply the most relevant national and international regulation on IoT

	Key performance indicators: Analyse national and international scope and requisites of personal data management Identify the main privacy issues in IoT environments
	Behaviours underpinning effective performance: Demonstrate ethical and legally correct approach in planning and implementing IoT technologies in the SMEs environment

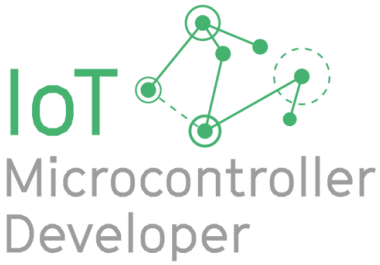
TOTAL ECVET POINTS: 0,75			
Key activities:	**Knowledge**	**Skills**	**Competences**
Illustrate and implement legal requirements related to IoT	Has factual and theoretical knowledge on general requirements of legal informatics	Identify and illustrate methods of integrating IoT technologies with specific regulation in SMEs sector	Supervise the work of the others in implementing IoT technologies in line with legal requirements
Describe and put into practice methods and tools for personal data management in line with national and international provisions	Has factual and theoretical knowledge in the field of: - Privacy - Personal information protection - Data protection - New EU regulation on data protection	Illustrate and support the implementation of national and international regulations regarding personal data management in European SMEs	Take the responsibility, within regulatory framework, to advice appropriate actions for the recognition of personal data protection Demonstrate autonomy in implementing methods in line with national and international provisions in the field of persona data management and protection
Apply the most relevant national and international regulation on IoT	Has factual and theoretical knowledge on the following topics: - Patents on IoT hardware and software - IoT standardization - Liabilities	Support the SMEs in implementing innovative IoT technologies respecting the national and international provisions	Supervise the work of the others in implementing IoT in line with legal requirements regarding standardization and liabilities procedures

	Unit 5 of Learning Outcomes**: Basics of networking and security**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Implement the different networking and communication protocols used in IoT environment Support the implementation of risk analysis related to IT security within Iot environments
	Key performance indicators: Monitor the correct implementation of networking and communication protocols
	Behaviours underpinning effective performance: Demonstrate accuracy in identifying networking and communication protocols' requirements for IoT environments Be impartial in illustrating the risk regarding the implementation of communication and networking protocols

TOTAL ECVET POINTS: 0,75			
Key activities:	**Knowledge**	**Skills**	**Competences**
Define and support the implementation of the different networking and communication protocols used in IoT environment	Has factual and theoretical knowledge on the following topics: - Networking protocols for IoT environments - Communication protocols for IoT environments	Illustrate and analyse the requirements of networking and communication protocols for IoT environments	Take the responsibility, within internal regulatory framework, to advice IoT users on the networking and communication protocols, based on organization's needs and objectives in implementing IoT
Support the implementation of risk analysis related to IT security within IoT environments	Has factual and theoretical knowledge on the following topics: - IoT security basics - Hardware vulnerabilities - Software vulnerabilities - Security risks regarding the implementation of networking and communication protocols Has factual and theoretical knowledge	Identify and analyse approaches and instruments for performing analysis to identify the concrete risks related to networking and communication protocols in IoT environments	Support the coordination of the risk analysis for IoT environments, according with the organization's guidelines. Take the responsibility to provide advice for addressing the risks identified

	on approaches and instruments for conducting risk analysis related to IoT		

4. QUALIFICATION TITLE: IoT Microcontrollers Developer

Title	**IoT Microcontrollers Developer**
Label	
EQF/NQF LEVEL (Recommended)	**EQF/NQF LEVEL : 5**

CORE UNITS OF LEARNING OUTCOMES	ECVET POINTS
Unit 1 Introduction: IoT technology and business strategy	0,75
Unit 2 Device architecture and sensors for microcontrollers	1,00
Unit 3 Programming microcontrollers	1,25
Unit 4 Platforms for microcontrollers and applications	1,00
Unit 5 Networking and Security (for microcontrollers)	1,00
TOTAL ECVET POINTS	**5,00**

Update requirements for the overall qualification: **every year**
(CPD – Continuous Professional Development)

Qualification update: **every 2 years**

*** ECVET POINTS**:

1 point = 25 hours of workload

1 day = 7 hour of workload

	Unit 1 of Learning Outcomes: **Introduction: IoT technology and business strategy**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse basics of IoT and its main applications in different sectors Analyse and provide creative and profitable approaches in designing components and services related to the most common hardware and software adopted Select and implement approaches regarding IoT communication technologies and platform Evaluate and illustrate specific reference regarding the main commonalities and differences between IoT and other technologies Supervise the implementation of the main national and international policies in the IoT field Provide advice to IoT customers on appropriate IoT solutions and opportunities to implement into their business Propose customized solutions for creating an IoT based business
	Key performance indicators: Make customized proposals and supervise the design and implementation of IoT components and services Creation of an IoT business
	Behaviours underpinning effective performance: Accuracy and precision in the design and implementation of IoT components and services Demonstrate ethical and legally correct approach in planning and implementing IoT in the business environment Be impartial in illustrating benefits and risks regarding the application of IoT

TOTAL ECVET POINTS: 0,75			
Key activities:	**Knowledge**	**Skills**	**Competencies**
Analyse basics of IoT and its main applications in different sectors	Has comprehensive, specialized, factual and theoretical knowledge on: - Internet of Things terminology - Technological trends which have led to IoT - Embedded systems in terms of interface	Implement innovative approaches for analysing and illustrating contents and specific links between IoT concepts Evaluate and describe the innovations offered by the most relevant IoT models and services, illustrating the	Supervise the definition and the application of generic characteristics of IoT Supervise and evaluate the work of the others and provide support for enhancing performance for

	- Impact of IoT on organizations/society - main application sectors of IoT - hardware and software components most commonly used in IoT devices	impact on organizations' development Illustrate specific approaches and frameworks for designing, developing and implementing IoT applications in different sectors Plan methods and tools for implementing the most common adopted hardware and software	an efficient implementation of the specific role attributed Manage the selection and supervise the implementation of the most adopted IoT technologies Make proposals to IoT users, based on the analysis conducted and future trends in the field
Analyse and provide creative and profitable approaches in designing components and services related to the most common hardware and software adopted	Has comprehensive, specialized, factual and theoretical knowledge on: 1. Microcontrollers 2. Microprocessors 3. Sensors 4. Actuator	Implement innovative approaches for analysing and illustrating the main features of the different IoT hardware and software	Supervise the evaluation process for identifying the strengths and the weaknesses of IoT hardware and software components
Select and implement approaches regarding IoT communication technologies and platforms	Has comprehensive, specialized, factual and theoretical knowledge on: 1. IoT protocols 2. IoT communication technologies 3. IoT communication platforms	Monitor and apply specific methods for enhancing IoT communication technologies and platforms	Supervise the definition of IoT technologies needed within the organization Manage the implementation of IoT communication technologies and platforms
Evaluate and illustrate specific reference regarding the main commonalities and differences between IoT and	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Cloud - Big Data - Industry 4.0	Implement innovative approaches for analysing and illustrating the specific characteristics of the different ICT technologies	Supervise the evaluation process for illustrating the strong and the weak characteristics of the various ICT technologies, compared to IoT

other technologies			
Supervise the implementation of the main national and international policies in the IoT field	Has comprehensive, specialized, factual and theoretical knowledge of the main different policies at national and international level, supporting the diffusion of IoT	Develop and advice the European SMEs on the implementation of innovative IoT technologies within their own organizations, respecting national and international provisions	Manage and supervise the implementation of appropriate actions for the dissemination of IoT technologies, within internal regulatory framework Make proposals for further improvements of IoT technologies and for solving unpredictable challenges
Provide advice to IoT customers on appropriate IoT solutions and opportunities to implement into own business	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Features of products and services internet connected - Benefits and challenges of the Internet of Things - Methods to measure the customers' satisfaction - New product features - New products offerings - Opportunities and competitive risks - Operational improvements and changes - IoT technologies in the market - Revenues and costs	Provide creative solutions for the application of IoT products and services Evaluate and describe in depth relevant good practices in the field of IoT technologies for SMEs, based on specific quality criteria Evaluate the opportunities that IoT could bring in the customers' satisfaction and customers' services fields Advice IoT users on the appropriate operational improvements and technologies to be implemented into their business	Manage the design and the implementation of customized IoT solutions for SMEs, according to their needs and types of services they offer Manage the evaluation process of the most relevant showcases in the field of IoT technologies and provide recommendations to IoT users on the most appropriate products and services in the field Manage the monitoring and identification process of the potential impact of IoT on business Supervise and provide creative solutions for the definition of appropriate IoT technologies for business based on revenues and costs analysis
Propose customized solutions for creating an IoT based business	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Strategy and alignment - Organization	Plan methods and tools for implementing business strategies using IoT to achieve objectives	Has the ability to manage and plan and to propose innovative strategies to optimise IoT driven business

	- Budgeting - Product development - Manufacturing - Distribution - Customer satisfaction - IoT solution - Organizational, management, financial resources - IoT offering - Skills and resources required for an IoT business	Propose and advice on the implementation of organizational, management and financial resources IoT technologies implemented into business Describe existing IoT technologies and propose new IoT based approaches/offering in line with the organization's context, for enhancing the IoT driven business Advice IoT customers concerning appropriate IoT solutions to be implemented for a successful IoT driven business, according to the organization's needs and development objectives Design supporting instruments for identifying skills and resources required to create a successful IoT business	Provide recommendations to SMEs on the most appropriate IoT services/solutions to implement in their own business, based on the needs and general trends in the fields Manage and supervise the identification of relevant strategies to implement in IoT businesses Provide advice on the type of IoT technologies required by the specific organization Supervise the monitoring and evaluation process for the implementation of skills and resources required to develop IoT business

	Unit 2 of Learning Outcomes**: Device architecture and sensors for microcontrollers**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Illustrate and implement the main methods to interface input/output peripherals with microcontroller devices Manage the efficient implementation of sensors, actuators and buses.
	Key performance indicators: Monitor appropriate understanding and implementation of peripherals' interfaces with microcontroller devices Monitor the correct implementation of sensors, actuators and buses
	Behaviours underpinning effective performance: Demonstrate a fair approach in illustrating innovative methods to interface peripherals with microcontroller devices

TOTAL ECVET POINTS: 1			
Key activities:	**Knowledge**	**Skills**	**Competences**
Illustrate and implement the main methods to interface input/output peripherals with microcontroller devices	Has comprehensive, specialized, factual and theoretical knowledge on: - Microcontrollers - Device architecture - Sensors and actuators issues Related network technologies	Propose creative approaches to interface peripheral devices with microcontrollers Propose and apply specific methods and tools for identifying challenges posed by sensor and actuators and provide recommendation for further improvements	Supervise the development and implementation of input/output peripherals with microcontroller devices Analyse and improve self and others' performance in identifying problems related to sensors and actuators
Manage the efficient implementation of sensors, actuators and buses	Has comprehensive, specialized, factual and theoretical knowledge on: - Analog sensors: voltage vs current - Digital sensors: on/off, parallel, serial, asynchronous vs synchronous - Pulse Width Modulation - Different kind of buses: I2C, SPI - Connection technologies	Evaluate and describe the main commonalities and differences between analog and digital sensor Propose innovative methods and tools for applying SPI and I2C communication protocols	Manage the selection and the implementation of different type of sensors Supervise the definition and the application of specific methods and tools for the implementation of different kind of buses

	Unit 3 of Learning Outcomes**: Programming microcontrollers**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Define and supervise the application of specific approaches to program microcontrollers Provide innovative solutions for the implementation of programming techniques with Arduino IDE and/or Eclipse Analyse and select approaches and tools for implementing practical experience in applying IoT
	Key performance indicators: Analyse tools and monitor the practical application of IoT technologies
	Behaviours underpinning effective performance: Have an equilibrate approach in selecting programming languages for microcontrollers .

TOTAL ECVET POINTS: 1,25			
Key activities:	**Knowledge**	**Skills**	**Competences**
Define and supervise the application of specific approaches to program microcontrollers	Has comprehensive, specialized, factual and theoretical knowledge on: - Microcontroller programming - C programming - Arduino - STM32	Advice IoT users on the appropriate programming language to be implemented according to the organizations' needs and development objectives Implement innovative approaches for analysing and illustrating the main features of microcontrollers (Arduino and STM32)	Supervise and evaluate the work of the others and provide support for enhancing performance for an efficient implementation of microcontrollers programming Manage the selection of the most appropriate method for implementation microcontrollers programming in line with IoT users' expectation
Provide innovative solutions for the implementation of programming techniques with Arduino IDE and/or Eclipse .	Has comprehensive, specialized, factual and theoretical knowledge on: - Arduino programming with Arduino IDE - Arduino I/O programming	Design and apply existing and innovative approaches and techniques to program with Arduino IDE Propose creative approaches and apply specific techniques to program with Eclipse	Supervise the development and the implementation of the most suitable programming techniques for the organization in line with its needs and general trends in the field

	- STM32 programming with Eclipse - STM32 I/O programming		
Analyse and select approaches and tools for implementing practical experience in applying IoT	Has comprehensive, specialized, factual and theoretical knowledge on: - Blinking LEDs - Controlling motors - Networking sensors	Design supportive instruments for enhancing the implementation of IoT technologies through practical experience (i.e. building blinking LEDs, controlling motors, networking sensors).	Supervise and evaluate the work of the others and provide support for enhancing practical experience in implementing IoT technologies

	Unit 4 of Learning Outcomes**: Platforms for microcontrollers and applications**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse and provide creative approaches regarding IoT devices' connection Evaluate and propose specific technologies for the implementation of protocols dedicated to IoT devices Is able to set up, configure and connect devices to IoT platforms providers
	Key performance indicators: Make customized proposal and supervise the design and the implementation of connectivity platforms for IoT devices
	Behaviours underpinning effective performance: Demonstrate legally correct and ethical approach in proposing specific technologies for ensuring the connectivity of IoT devices

TOTAL ECVET POINTS: 1,0

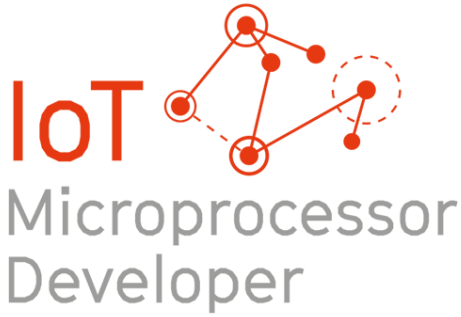
Key activities:	Knowledge	Skills	Competences
Analyse and provide creative approaches regarding IoT devices' connection	Has comprehensive, specialized, factual and theoretical knowledge on connecting devices to local or global networks	Illustrate and provide innovative solutions for IoT devices' connection to local or global networks	Provide advice to IoT users' on the implementation of local and global network connectivity of IoT devices

Evaluate and propose specific technologies for the implementation of protocols dedicated to IoT devices	Has comprehensive, specialized, factual and theoretical knowledge on: - Low Level protocols dedicated to IoT devices - High Level protocols dedicated to IoT devices	Analyse and implement existing Low and High level protocols for IoT devices	Supervise the definition and the appropriate implementation of Low Level and High Level IoT protocols
Is able to set up, configure and connect devices to IoT platforms providers	Has comprehensive, specialized, factual and theoretical knowledge of IoT platforms: ThinkSpeak, ThinkWorx, Ubidots, etc.	Has a comprehensive range of abilities in order to propose and implement techniques for connecting devices to/of IoT platforms according the IoT users' requirements	Manage the development and the implementation of the most suitable techniques for connectivity platforms for IoT devices Review self and others performance in the field and provide support for further improvement

	Unit 5 of Learning Outcomes: **Networking and Security (for microcontrollers)**		
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD		
	Key activities supported by the learning outcomes: Analyse and make customized proposals to implement different networking and communication protocols used in IoT environment Is able to perform risk analysis related to IoT security within organizations		
	Key performance indicators: Define customized approaches for guarantee the correct implementation of networking and communication protocols		
	Behaviours underpinning effective performance: Demonstrate a fair and ethical behaviour in tackling organization's security challenges in IoT environments		
TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Analyse and make customized proposals to implement	Has comprehensive, specialized, factual and theoretical knowledge on:	Advice IoT users on the proper networking and communication protocol to be implemented in IoT environments	Manage and supervise the technical implementation of the different networking and communication protocols

different networking and communication protocols used in IoT environment	- Networking protocols for IoT environments - Communication protocols for IoT environments		and recommend solutions for new challenges arose
Is able to perform risk analysis related to IoT security within organizations	Has comprehensive, specialized, factual and theoretical knowledge on: - IoT security basics - Hardware vulnerabilities in microcontrollers: Arduino example - Software vulnerabilities in microcontrollers: Arduino example - Security risks regarding the implementation of networking and communication protocols	Conduct risk analysis using existing and innovative methods and tools for identifying security challenges in IoT environments and provide recommendations for further improvements Monitor and analyse hardware and software vulnerabilities In microcontrollers for supporting further improvements	Analyse and improve self and others' performance in conducting risk analysis for enhancing the IoT security

5. QUALIFICATION TITLE: IoT Microprocessors Developer

Title	**IoT Microprocessors Developer**
Label	
EQF/NQF LEVEL (Recommended)	**EQF/NQF LEVEL 5**

CORE UNITS OF LEARNING OUTCOMES	ECVET POINTS
Unit 1 Introduction: IoT technology and business strategy	0,75
Unit 2 Device architecture and sensors for microprocessors	1,00
Unit 3 Programming microprocessors	1,25
Unit 4 Platforms for microprocessors and applications	1,00
Unit 5 Networking and Security (for microprocessors)	1,00
TOTAL ECVET POINTS	**5,00**

Update requirements for the overall qualification: **every year**
(CPD – Continuous Professional Development)

Qualification update: **every 2 years**

*** ECVET POINTS**:

1 point = 25 hours of workload

1 day = 7 hour of workload

	Unit 1 of Learning Outcomes: **Introduction: IoT technology and business strategy**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse basics of IoT and its main applications in different technical and business sectors Analyse and provide creative and profitable approaches in designing components and services related to the most common hardware and software adopted Select and implement approaches regarding IoT communication technologies and platform Evaluate and illustrate specific reference regarding the main commonalities and differences between IoT and other technologies Supervise the implementation of the main national and international policies in the IoT field Provide advice to IoT customers on appropriate IoT solutions and opportunities to implement into their business Propose customized solutions for IoT business setup
	Key performance indicators: Make customized proposals and supervise the design and implementation of IoT components and services Creation of an IoT business
	Behaviours underpinning effective performance: Accuracy and precision in the design and implementation of IoT components and services Demonstrate ethical and legally correct approach in planning and implementing IoT in the business environment Be impartial in illustrating benefits and risks regarding the application of IoT

TOTAL ECVET POINTS: 0,75			
Key activities:	**Knowledge**	**Skills**	**Competencies**
Analyse basics of IoT and its main applications in different sectors	Has comprehensive, specialized, factual and theoretical knowledge on: - Internet of Things terminology - Technological trends which have led to IoT - Embedded systems in terms of interface - Impact of IoT on organizations/society	Implement innovative approaches for analysing and illustrating contents and specific links between IoT concepts Evaluate and describe the innovations offered by the most relevant IoT models and services, illustrating the impact on organizations' development	. Supervise the definition and the application of generic characteristics of IoT Supervise and evaluate the work of the others and provide support for enhancing performance for an efficient implementation of the specific role attributed

	- main application sectors of IoT - hardware and software components most commonly used in IoT devices	Illustrate specific approaches and frameworks for designing, developing and implementing IoT applications in different sectors Plan methods and tools for implementing the most common adopted hardware and software	Manage the selection and supervise the implementation of the most adopted IoT technologies Make proposals to IoT users, based on the analysis conducted and future trends in the field
Analyse and provide creative and profitable approaches in designing components and services related to the most common hardware and software adopted	Has comprehensive, specialized, factual and theoretical knowledge on: 1. Microcontrollers 2. Microprocessors 3. Sensors 4. Actuators	Implement innovative approaches for analysing and illustrating the main features of the different IoT hardware and software .	Supervise the evaluation process for identifying the strengths and the weaknesses of IoT hardware and software components
Select and implement approaches regarding IoT communication technologies and platforms	Has comprehensive, specialized, factual and theoretical knowledge on: 1. IoT protocols 2. IoT communication technologies 3. IoT communication platforms	Monitor and apply specific methods for enhancing IoT communication technologies and platforms	Supervise the definition of IoT technologies needed within the organization Manage the implementation of IoT communication technologies and platforms
Evaluate and illustrate specific reference regarding the main commonalities and differences between IoT and other technologies	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Cloud - Big Data - Industry 4.0	Implement innovative approaches for analysing and illustrating the specific characteristics of the different ICT technologies	Supervise the evaluation process for illustrating the strong and the weak characteristics of the various ICT technologies, compared to IoT

Supervise the implementation of the main national and international policies in the IoT field	Has comprehensive, specialized, factual and theoretical knowledge of the main different policies at national and international level, supporting the diffusion of IoT	Develop and advice the European SMEs on the implementation of innovative IoT technologies within their own organizations, respecting national and international provisions	Manage and supervise the implementation of appropriate actions for the dissemination of IoT technologies, within internal regulatory framework Make proposals for further improvements of IoT technologies and for solving unpredictable challenges
Provide advice to IoT customers on appropriate IoT solutions and opportunities to implement into own business	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Features of products and services internet connected - Benefits and challenges of the Internet of Things - Methods to measure the customers' satisfaction - New product features - New products offerings - Opportunities and competitive risks - Operational improvements and changes - IoT technologies in the market - Revenues and costs	Provide creative solutions for the application of IoT products and services Evaluate and describe in depth relevant good practices in the field of IoT technologies for SMEs, based on specific quality criteria Evaluate the opportunities that IoT could bring in the customers' satisfaction and customers' services fields Advice IoT users on the appropriate operational improvements and technologies to be implemented into their business	Manage the design and the implementation of customized IoT solutions for SMEs, according to their needs and types of services they offer Manage the evaluation process of the most relevant showcases in the field of IoT technologies and provide recommendations to IoT users on the most appropriate products and services in the field Manage the monitoring and identification process of the potential impact of IoT on business Supervise and provide creative solutions for the definition of appropriate IoT technologies for business based on revenues and costs analysis
Propose customized solutions for IoT business setup	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Strategy and alignment - Organization - Budgeting	Plan methods and tools for implementing business strategies using IoT to achieve objectives Propose and advice on the implementation of	Has the ability to manage and plan and to propose innovative strategies to optimise IoT driven business Provide recommendations to SMEs on the most

	- Product development - Manufacturing - Distribution - Customer satisfaction - IoT solution - Organizational, management, financial resources - IoT offering - Skills and resources required for an IoT business	organizational, management and financial resources IoT technologies implemented into business Describe existing IoT technologies and propose new IoT based approaches/offering in line with the organization's context, for enhancing the IoT driven business Advice IoT customers concerning appropriate IoT solutions to be implemented for a successful IoT driven business, according to the organization's needs and development objectives Design supporting instruments for identifying skills and resources required to create a successful IoT business	appropriate IoT services/solutions to implement in their own business, based on the needs and general trends in the fields Manage and supervise the identification of relevant strategies to implement in IoT businesses Provide advice on the type of IoT technologies required by the particular organization Supervise the monitoring and evaluation process for the implementation of skills and resources required to develop IoT business

	Unit 2 of Learning Outcomes**: Device architecture and sensors for microprocessors**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Illustrate and implement the main methods to interface input/output peripherals with microprocessors devices Manage the efficient implementation of sensors, actuators and buses
	Key performance indicators: Monitor appropriate understanding and implementation of peripherals' interfaces with microprocessor devices Monitor the correct implementation of sensors, actuators and buses

	Behaviours underpinning effective performance: Demonstrate a fair approach in illustrating innovative methods to interface peripherals with microprocessors devices

TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Illustrate and implement the main methods to interface input/output peripherals with microprocessor devices	Has comprehensive, specialized, factual and theoretical knowledge on: - Microprocessors - Device architecture - Sensors and actuators issues - Related network technologies	Propose creative approaches to interface peripheral devices with microprocessors Propose and apply specific methods and tools for identifying challenges posed by sensor and actuators and provide recommendation for further improvements	Supervise the development and implementation of input/output peripherals with microprocessor devices Analyse and improve self and others' performance in identifying problems related to sensors and actuators
Manage the efficient implementation of sensors, actuators and buses	Has comprehensive, specialized, factual and theoretical knowledge on: - Analog sensors: voltage vs current - Digital sensors: on/off, parallel, serial, asynchronous vs synchronous - Pulse Width Modulation - Different kind of buses: I2C, SPI - Connection technologies	Evaluate and describe the main commonalities and differences between analog and digital sensor Propose innovative methods and tools for applying SPI and I2C communication protocols	Manage the selection and the implementation of different type of sensors Supervise the definition and the application of specific methods and tools for the implementation of different kind of buses

	Unit 3 of Learning Outcomes**: Programming microprocessors**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Define and supervise the application of specific approaches to program microprocessors Provide innovative solutions for the implementation of programming techniques with Raspberry Pi Analyse and select approaches and tools for implementing practical experience in applying IoT Describe and apply methods and tools to write customized modules
	Key performance indicators: Analyse tools and monitor the practical application of IoT technologies
	Behaviours underpinning effective performance: Have an equilibrate approach in selecting programming languages for microprocessors

TOTAL ECVET POINTS: 1,25			
Key activities:	**Knowledge**	**Skills**	**Competences**
Define and supervise the application of specific approaches to program microprocessors	Has comprehensive, specialized, factual and theoretical knowledge on: - Microprocessors programming - Python programming - Raspberry Pi programming	Analyse and describe characteristics of the Phyton programming languages for Raspberry Pi Advice IoT users on the appropriate programming language to be implemented according to the organizations' needs and development objectives Implement innovative approaches for analysing and illustrating the main features of microprocessors	Supervise and evaluate the work of the others and provide support for enhancing performance for an efficient implementation of microprocessors programming Manage the selection of the most appropriate method for implementation microprocessors programming in line with IoT users' expectation
Provide innovative solutions for the implementation of programming techniques with Raspberry Pi	Has comprehensive, specialized, factual and theoretical knowledge on: - Python programming in Raspberry Pi	Design and apply existing and innovative approaches and techniques to program with Python	Supervise the development and the implementation of the most suitable programming techniques for the organization in line with its needs and general trends in the field

	- Raspberry Pi I/O programming	Propose creative approaches and apply specific techniques to program with Raspberry Pi	
Analyse and select approaches and tools for implementing practical experience in applying IoT	Has comprehensive, specialized, factual and theoretical knowledge on: - Program Raspberry Pi's output pins - Read sensor data from Raspberry Pi's input pins	Design supportive instruments for enhancing the implementation of IoT technologies through practical experience (i.e. blinking a LED, reading sensor data)	Supervise and evaluate the work of the others and provide support for enhancing practical experience in implementing IoT technologies
Describe and apply methods and tools to write customized modules	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Operating System - Interfacing sensor with the Operating System	Describe and analyse the main features of the Operating System.	Based on internal standards and requirement, support the implementation of specific writing modules methods and instruments

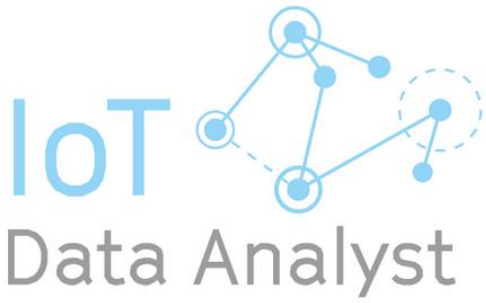
	Unit 4 of Learning Outcomes**: Platforms for microprocessors and applications**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse and provide creative approaches regarding IoT devices' connection Evaluate and propose specific technologies for the implementation of protocols dedicated to IoT devices Is able to set up, configure and connect devices to IoT platforms providers
	Key performance indicators: Make customized proposal and supervise the design and the implementation of connectivity platforms for IoT devices.
	Behaviours underpinning effective performance: Demonstrate legally correct and ethical approach in proposing specific technologies for ensuring the connectivity of IoT devices
TOTAL ECVET POINTS: 1,00	

Key activities:	Knowledge	Skills	Competences
Analyse and provide creative approaches regarding IoT devices' connection	Has comprehensive, specialized, factual and theoretical knowledge on connecting devices to local or global networks	Illustrate and provide innovative solutions for IoT devices' connection to local or global networks	Provide advice to IoT users' on the implementation of local and global network connectivity of IoT devices
Evaluate and propose specific technologies for the implementation of protocols dedicated to IoT devices	Has comprehensive, specialized, factual and theoretical knowledge on: - Low Level protocols dedicated to IoT devices - High Level protocols dedicated to IoT devices	Analyse and implement existing Low and High level protocols for IoT devices	Supervise the definition and the appropriate implementation of Low Level and High Level IoT protocols
Is able to set up, configure and connect devices to IoT platforms providers	Has comprehensive, specialized, factual and theoretical knowledge of IoT platforms: ThinkSpeak, ThinkWorx, Ubidots, etc.	Has a comprehensive range of capabilities in order to propose and implement techniques for connecting devices to/of IoT platforms according the IoT users' requirements	Manage the development and the implementation of the most suitable techniques for connectivity platforms for IoT devices Review self and others performance in the field and provide support for further improvement

	Unit 5 of Learning Outcomes: **Networking and Security (for microprocessors)**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse and make customized proposals to implement different networking and communication protocols used in IoT environment Is able to perform risk analysis related to IoT security within organizations
	Key performance indicators: Define customized approaches in order to guarantee the correct implementation of networking and communication protocols

	Behaviors underpinning effective performance: Demonstrate a fair and ethical behaviour in tackling organization's security challenges in IoT environments		
TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Analyse and make customized proposals to implement different networking and communication protocols used in IoT environment	Has comprehensive, specialized, factual and theoretical knowledge on: - Networking protocols for IoT environments - Communication protocols for IoT environments	Advice IoT users on the proper networking and communication protocol to be implemented in IoT environments	Manage and supervise the technical implementation of the different networking and communication protocols and recommend solutions for new challenges arose
Is able to perform risk analysis related to IoT security within organizations	Has comprehensive, specialized, factual and theoretical knowledge on: - IoT security basics - Hardware vulnerabilities in microprocessors: Raspberry Pi example - Software vulnerabilities in microprocessors: Raspberry Pi example - Security risks regarding the implementation of networking and communication protocols	Conduct risk analysis based on methods and tools concerning security challenges in IoT environments and provide recommendations for further improvements Monitor and analyse hardware and software vulnerabilities in microprocessors for supporting further improvements	Analyse and improve self and others' performance in conducting risk analysis for enhancing the IoT security

6. QUALIFICATION TITLE: IoT Data Analyst

Title	**IoT Data Analyst**
Label	
EQF/NQF LEVEL (Recommended)	**EQF/NQF LEVEL 5**

CORE UNITS OF LEARNING OUTCOMES	ECVET POINTS
Unit 1 Introduction: IoT technology and business strategy	0,75
Unit 2 Device architecture and sensors	1,00
Unit 3 Networking and security	1,00
Unit 4 IoT data analysis	1,25
Unit 5 IoT platforms	1,00
TOTAL ECVET POINTS	**5,00**

Update requirements for the overall qualification: **every year**
(CPD – Continuous Professional Development)

Qualification update: **every 2 years**

*** ECVET POINTS**:

1 point = 25 hours of workload

1 day = 7 hour of workload

	Unit 1 of Learning Outcomes: **Introduction: IoT technology and business strategy**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse basics of IoT and its main applications in different technical and business sectors Analyse and provide creative and profitable approaches in designing components and services related to the most common hardware and software adopted Select and implement approaches regarding IoT communication technologies and platform Evaluate and illustrate specific reference regarding the main commonalities and differences between IoT and other technologies Supervise the implementation of the main national and international policies in the IoT field Provide advice to IoT customers on appropriate IoT solutions and opportunities to implement into their business Propose customized solutions for IoT business setup
	Key performance indicators: Make customized proposals and supervise the design and implementation of IoT components and services Creation of an IoT business
	Behaviours underpinning effective performance: Accuracy and precision in the design and implementation of IoT components and services Demonstrate ethical and legally correct approach in planning and implementing IoT in the business environment Be impartial in illustrating benefits and risks regarding the application of IoT

TOTAL ECVET POINTS:			
Key activities:	**Knowledge**	**Skills**	**Competencies**
Analyse basics of IoT and its main applications in different sectors	Has comprehensive, specialized, factual and theoretical knowledge on: - Internet of Things terminology - Technological trends which have led to IoT - Embedded systems in terms of interface	Implement innovative approaches for analysing and illustrating contents and specific links between IoT concepts Evaluate and describe the innovations offered by the most relevant IoT models and services, illustrating the	Supervise the definition and the application of generic characteristics of IoT Supervise and evaluate the work of the others and provide support for enhancing performance for

	- Impact of IoT on organizations/society - main application sectors of IoT - hardware and software components most commonly used in IoT devices	impact on organizations' development Illustrate specific approaches and frameworks for designing, developing and implementing IoT applications in different sectors Plan methods and tools for implementing the most common adopted hardware and software	an efficient implementation of the specific role attributed Manage the selection and supervise the implementation of the most adopted IoT technologies Make proposals to IoT users, based on the analysis conducted and future trends in the field
Analyse and provide creative and profitable approaches in designing components and	Has comprehensive, specialized, factual and theoretical knowledge on: 1. Microcontrollers 2. Microprocessors 3. Sensors 4. Actuators	Implement innovative approaches for analysing and illustrating the main features of the different IoT hardware and software	Supervise the evaluation process for identifying the strengths and the weaknesses of IoT hardware and software components
Select and implement approaches regarding IoT communication technologies and platforms	Has comprehensive, specialized, factual and theoretical knowledge on: 1. IoT protocols 2. IoT communication technologies 3. IoT communication platforms	Monitor and apply specific methods for enhancing IoT communication technologies and platforms	Supervise the definition of IoT technologies needed within the organization Manage the implementation of IoT communication technologies and platforms
Evaluate and illustrate specific reference regarding the main commonalities and differences between IoT and other technologies	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Cloud - Big Data - Industry 4.0	Implement innovative approaches for analysing and illustrating the specific characteristics of the different ICT technologies	Supervise the evaluation process for illustrating the strong and the weak characteristics of the various ICT technologies, compared to IoT

Supervise the implementation of the main national and international policies in the IoT field	Has comprehensive, specialized, factual and theoretical knowledge of the main different policies at national and international level, supporting the diffusion of IoT	Develop and advice the European SMEs on the implementation of innovative IoT technologies within their own organizations, respecting national and international provisions	Manage and supervise the implementation of appropriate actions for the dissemination of IoT technologies, within internal regulatory framework Make proposals for further improvements of IoT technologies and for solving unpredictable challenges
Provide advice to IoT customers on appropriate IoT solutions and opportunities to implement into own business	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Features of products and services internet connected - Benefits and challenges of the Internet of Things - Methods to measure the customers' satisfaction - New product features - New products offerings - Opportunities and competitive risks - Operational improvements and changes - IoT technologies in the market - Revenues and costs	Provide creative solutions for the application of IoT products and services Evaluate and describe in depth relevant good practices in the field of IoT technologies for SMEs, based on specific quality criteria Evaluate the opportunities that IoT could bring in the customers' satisfaction and customers' services fields Advice IoT users on the appropriate operational improvements and technologies to be implemented into their business	Manage the design and the implementation of customized IoT solutions for SMEs, according to their needs and types of services they offer Manage the evaluation process of the most relevant showcases in the field of IoT technologies and provide recommendations to IoT users on the most appropriate products and services in the field Manage the monitoring and identification process of the potential impact of IoT on business Supervise and provide creative solutions for the definition of appropriate IoT technologies for business based on revenues and costs analysis
Propose customized solutions for IoT business setup	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Strategy and alignment - Organization - Budgeting - Product development	Plan methods and tools for implementing business strategies using IoT to achieve objectives Propose and advice on the implementation of organizational, management	Has the ability to manage and plan and to propose innovative strategies to optimise IoT driven business Provide recommendations to SMEs on the most appropriate IoT

	- Manufacturing - Distribution - Customer satisfaction - IoT solution - Organizational, management, financial resources - IoT offering - Skills and resources required for an IoT business	and financial resources IoT technologies implemented into business Describe existing IoT technologies and propose new IoT based approaches/offering in line with the organization's context, for enhancing the IoT driven business Advice IoT customers concerning appropriate IoT solutions to be implemented for a successful IoT driven business, according to the organization's needs and development objectives Design supporting instruments for identifying skills and resources required to create a successful IoT business	services/solutions to implement in their own business, based on the needs and general trends in the fields Manage and supervise the identification of relevant strategies to implement in IoT businesses Provide advice on the type of IoT technologies required by the particular organization Supervise the monitoring and evaluation process for the implementation of skills and resources required to develop IoT business

	Unit 2 of Learning Outcomes**: Device architecture and sensors**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse and provide creative approaches to implement customized input/output peripherals' interfaces based on customers' requirements and future trends Manage the efficient implementation of sensors, actuators and buses
	Key performance indicators: Make customized proposals and supervise the design and implementation of peripherals' interfaces Monitor the correct implementation of sensors, actuators and buses.
	Behaviours underpinning effective performance:

	Accuracy and precision in designing and implementing innovative methods to interface I/O peripheral devices

TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Analyse and provide creative approaches to implement customized input/output peripherals' interfaces based on customers' requirements and future trends	Has comprehensive, specialized, factual and theoretical knowledge on: - Device architecture - Sensors and actuators issues Related network technologies	Propose creative approaches to interface input/output peripheral devices based on customers' requirements Propose and apply specific methods and tools for identifying challenges posed by sensor and actuators and provide recommendation for further improvements Make proposals and implement front end and back end platforms customized for the organization's requirements.	Supervise the development and implementation of I/O peripherals' interfaces Analyse and improve self and others' performance in identifying problems related to sensors and actuators
Manage the efficient implementation of sensors, actuators and buses	Has comprehensive, specialized, factual and theoretical knowledge on: - Analog sensors: voltage vs current - Digital sensors: on/off, parallel, serial, asynchronous vs synchronous - Pulse Width Modulation - Different kind of buses: I2C, SPI - Connection technologies	Evaluate and describe the main commonalities and differences between analog and digital sensor Propose innovative methods and tools for applying SPI and I2C communication protocols	Manage the selection and the implementation of different type of sensors Supervise the definition and the application of specific methods and tools for the implementation of different kind of buses

	Unit 3 of Learning Outcomes**: Networking and security**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse and make customized proposals to implement different networking and communication protocols used in IoT environment

	Is able to perform risk analysis related to IoT security within organizations
	Key performance indicators: Define customized approaches in order to guarantee the correct implementation of networking and communication protocols .
	Behaviours underpinning effective performance: Demonstrate a fair and ethical behaviour in tackling organization's security challenges in IoT environments

TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Analyse and make customized proposals to implement different networking and communication protocols used in IoT environment	Has comprehensive, specialized, factual and theoretical knowledge on: - Networking protocols for IoT environments - Communication protocols for IoT environments	Advice IoT users on the proper networking and communication protocol to be implemented in IoT environments	Manage and supervise the technical implementation of the different networking and communication protocols and recommend solutions for new challenges arose
Is able to perform risk analysis related to IoT security within organizations	Has comprehensive, specialized, factual and theoretical knowledge on: - IoT security basics - Hardware vulnerabilities - Software vulnerabilities - Security risks regarding the implementation of networking and communication protocols	Conduct risk analysis based on methods and tools concerning security challenges in IoT environments and provide recommendations for further improvements Monitor and analyse hardware and software vulnerabilities for supporting further improvements	Analyse and improve self and others' performance in conducting risk analysis for enhancing the IoT security

	Unit 4 of Learning Outcomes: **IoT data analysis**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Describe and implement cloud storage and cloud analytics services and technologies Analyse and apply Big Data Analytics tools to improve data management Provide innovative solution for the implementation of machine learning for IoT Select and describe relevant examples of analytic engines and frameworks for IoT
	Key performance indicators: Monitor the correct implementation of a cloud storage and a cloud analytics services
	Behaviors underpinning effective performance: Be impartial in illustrating benefits and risks regarding the application of cloud storage and cloud analytics services Have an equilibrate approach in analysing and applying Big data analytics for IoT purposes in connection with data management tools

TOTAL ECVET POINTS: 1,25

Key activities:	Knowledge	Skills	Competences
Describe and implement cloud storage and cloud analytics services and technologies	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Basics of Cloud storage - Basics of Cloud analytics	Explain to the organization's representatives existing cloud storage and cloud analytics services and technologies that could be implemented according with the organization's needs and performance objectives	Supervise the routine work of the personnel for ensuring the efficient implementation of the chosen cloud service
Analyse and apply Big Data Analytics tools to improve data management	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Big Data for IoT - Big Data Analytics Techniques - Introduction to Hadoop Data Management - Introduction to "R" for statistical purposes	Describe the relevant features of Big Data for IoT and implement specific techniques concerning Big Data Analytics Describe and analyse the main characteristics of data management tools, and advice on the implementation of Hadoop for IoT and "R" for statistical purposes	Supervise the implementation of Big Data Analytics techniques for IoT environments Manage the definition and the analysis of data management tools for IoT within the organization

Provide innovative solution for the implementation of machine learning for IoT	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Introduction to machine learning - Machine learning classification techniques - Bayesian prediction - Image and video analytic for IoT - Options for the implementation of machine learning for IoT - Biometric ID integration with IoT - Real time analytic/stream analytic - Scalability issues for IoT and machine learning	Describe machine learning characteristics showing the possible impact on organization's development Develop and apply customized methods and tools for the implementation of machine learning for IoT	Manage and control the technical implementation of machine learning classification techniques in line with the organizational context
Select and describe relevant examples of analytic engines and frameworks for IoT	Has comprehensive, specialized, factual and theoretical knowledge on the following topics: - Visualization analytic - Structured and unstructured predictive analytics - Recommendation engines - Pattern direction - Frameworks for distributed data analysis	Describe in depth relevant examples in IoT field concerning analytic engines and frameworks and demonstrate their impact on technological trends at international level and for organizations	Assess and improve self and others' performance in selecting examples

	Unit 5 of Learning Outcomes**: IoT platforms**
	RELATED PERFORMANCE DESCRIPTION/OCCUPATIONAL STANDARD
	Key activities supported by the learning outcomes: Analyse and provide creative approaches regarding IoT devices' connection

	Evaluate and propose specific technologies for the implementation of protocols dedicated to IoT devices Is able to set up, configure and connect devices to IoT platforms providers
	Key performance indicators: Make customized proposal and supervise the design and the implementation of connectivity platforms for IoT devices
	Behaviours underpinning effective performance: Demonstrate legally correct and ethical approach in proposing specific technologies for ensuring the connectivity of IoT devices

TOTAL ECVET POINTS: 1,00			
Key activities:	**Knowledge**	**Skills**	**Competences**
Analyse and provide creative approaches regarding IoT devices' connection	Has comprehensive, specialized, factual and theoretical knowledge on connecting devices to local or global networks	Illustrate and provide innovative solutions for IoT devices' connection to local or global networks	Provide advice to IoT users' on the implementation of local and global network connectivity of IoT devices
Evaluate and propose specific technologies for the implementation of protocols dedicated to IoT devices	Has comprehensive, specialized, factual and theoretical knowledge on: - Low Level protocols dedicated to IoT devices - High Level protocols dedicated to IoT devices	Analyse and implement existing Low and High level protocols for IoT devices	Supervise the definition and the appropriate implementation of Low Level and High Level IoT protocols
Is able to set up, configure and connect devices to IoT platforms providers	Has comprehensive, specialized, factual and theoretical knowledge of IoT platforms: ThinkSpeak, ThinkWorx, Ubidots, etc	Has a comprehensive range of capabilities in order to propose and implement techniques for connecting devices to/of IoT platforms according the IoT users' requirements	Manage the development and the implementation of the most suitable techniques for connectivity platforms for IoT devices Review self and others performance in the field and provide support for further improvement