

Digital Transformation in Advanced Manufacturing

DTAM Curriculum



DTAM

DIGITAL TRANSFORMATION IN
ADVANCED MANUFACTURING



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Deliverable factsheet

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- “R2.4: DTAM Teacher/Trainer Manual” of WP2: this deliverable will provide an integral guide to the DTAM curriculum for H/VET staff who will deliver the training as part of formal accredited training in IVET and CVET courses.

2 Curriculum development

This section describes the methodology followed for the development of the DTAM curriculum. More specific:

- Section 2.1 describes the key characteristics of the DTAM curriculum
- Section 2.2 describes the key terms used in the curriculum
- Section 2.3 describes the process adopted for the development of the curriculum

2.1 Key characteristics of the DTAM curriculum

The main documents that have been used as reference for the development of the DTAM curriculum are the following:

- The “[Digital Transformation Skills Index](#)” developed by the DTAM project. This index has been used as a base for the definition of the knowledge and skills of each separate training module of the curriculum.
- The [CEDEFOP report for defining, writing and applying learning outcomes](#) [1]. This report provides guidelines for effectively defining, writing and applying learning outcomes at VET.
- The [EC Curriculum guidelines for Key Enabling Technologies \(KETs\) and Advanced Manufacturing Technologies \(AMT\)](#) report [2]. This report provides a new curriculum framework for AM.

The DTAM Curriculum has been developed following a student-centered approach. Its main characteristics are the following:

- **Multi-disciplinary:** The curriculum provides the learners with technical competences at digital technologies for AM (e.g. big data, artificial intelligence, Internet of Things), as well as competences covering non-technical non-technical/transversal areas (e.g. leadership, communication, project management).
- **Modular:** The curriculum includes a set of training modules. Each module is further divided into learning units. This permits the learners to build their own learning pathways based on their needs.
- **Innovative:** The curriculum promotes problem (challenge)-driven learning, collaborative (collective) learning, technology-enabled learning, as well as experience-based learning.

2.2 Key terms used in the curriculum

The key terms used in the DTAM curriculum are the following:

- Learning outcomes
- Competence
- Knowledge
- Skill
- Learning units

2.2.4 Skill

ESCO applies the same definition of "skill" as the EQF. https://ec.europa.eu/esco/portal/escopedia/European_Qualifications_Framework_40_EQF_41 According to this "skill means the ability to apply knowledge and use know-how to complete tasks and solve problems". They can be described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

While sometimes used as synonyms, the terms skill and competence can be distinguished according to their scope. The term skill refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. The term competence is broader and refers typically to the ability of a person - facing new situations and unforeseen challenges - to use and apply knowledge and skills in an independent and self-directed way.

2.2.5 Training module

A training module includes a set of learning units that are delivered using various means (i.e. online, face-to-face, blended) to get the students the desired competences in terms of knowledge and skills.

2.3 Development of DTAM curriculum

The DTAM curriculum has been developed taking into account European tools and instruments, like the EQF, ECVET and ESCO, ensuring its transferability and recognition among European countries.

The process followed for developing the DTAM curriculum will consist of three stages

- **Defining curriculum goals and specific learning outcomes.** For the case of the DTAM curriculum, its main goals are two:
 - Provide AM technicians with technical and non-technical competences that meet the industry's demand.
 - Develop an innovative AM learning ecosystem, that promotes problem-based learning, technology-enhanced learning, and experience-based learning

Note that the learning outcomes of the DTAM curriculum, i.e. knowledge and skills of each separate training module, have been considering the ECVET recommendations [9].

- **Developing relevant teaching methods and forms of assessment.** At this stage is defining the methodology for the delivery of the DTAM curriculum in different learning scenarios, as well as the methodology for learners' assessment. As an initial approach, the DTAM curriculum will be delivered combining both online and face-to-face training exploiting the IoT labs that will be developed under WP4. For learners' assessment, we are currently considering both self-assessment and exercises/challenges. However, all the details about the training methodology of

the DTAM curriculum will be defined at the deliverable “D2.3: DTAM Training Methodology” under WP2.

- **Reviewing and refining the curriculum.** As the curriculum development is a continuous-learning process, the DTAM curriculum have been reviewed by the DTAM partners involved at the development of the training material (WP3), i.e., APRO, UPATRAS, ATLANTIS, DA VINCI, TXORRIERI and IDEC. Moreover, it will reviewer again after the completion of the pilots, in order to make fine-tuning changes based on their findings.

The separate training modules (courses) of the curriculum have been developed by each partner that is responsible to develop the respective training material under WP3. Thus

- APRO developed the “TM1: Information Technology and Operational Technology”.
- UPATRAS developed the “TM2: Big Data”.
- ATLANTIS developed the “TM3: Machine Learning”.
- DA VINCI developed the “TM4: Internet of Things and sensors”.
- TXORRIERI developed the “TM5: Cyber Security”.
- IDEC developed the “TM6: Transversal Competences”.

3 Curriculum Description

The DTAM curriculum follows a multi-disciplinary approach, combining technical with non-technical competences for AM technicians. It also follows a modular approach that support the need for micro-learning. The 6 training modules (courses) that consist of the DTAM curriculum are the following:

- TM1: Information Technology and Operational Technology
- TM2: Big Data
- TM3: Machine Learning
- TM4: Internet of Things and Sensors
- TM5: Cyber Security
- TM6: Transversal Competences

The description of each training module includes:

- Course name, code, duration and ECVET credits.
- Course description.
- Course objectives.
- Learning outcomes.
- Teaching and learning methods.
- Assessment methods.
- Learning units.
- Course outline

3.1 Description of training modules

3.1.1 TM1: Information Technology and Operational Technology

| | |
|----------------------|---|
| COURSE NAME | Information Technology and Operational Technology |
| COURSE CODE | IN |
| DURATION | 40 hours |
| ECVET CREDITS | 2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training) |

COURSE DESCRIPTION

This training module aims to provide the learners with the basic knowledge and skills for the information technology, as well as the operational technology. It provides an overview of IT systems, IT networking and electronic fundamentals. As Python is the programming language that is used through the DTAM curriculum, this training module makes also an introduction to programming with Python. At the end of the module, you will learn the basics of Information and Operational Technology that are essentials for the AM technicians.

OBJECTIVES

This unit aims to:

- O1 Provide basic information on managing Personal Computer and Raspberry hardware and software
- O2 Illustrate the operation and configuration of computer network systems
- O3 Approaching Python programming and the use of databases
- O4 Provide basic training in the world of electronics, the fundamental laws of electrical engineering and the use of measuring instruments
- O5 Developing green skills with reference to current sustainability regulations

LEARNING OUTCOMES

| EQF level 4 (VET) / EQF level 5+ (HE) | | Link to aims |
|---|---|--------------|
| <i>As the aim of introduction is to close the gap detected using the Digital Self Evaluation Tool, there is no difference between levels 4 and 5.</i> | | |
| By the end of the course, the students will (knowledge): | | |
| K.A1 | Know the fundamentals of PC systems and Raspberry PI, including hardware characteristics, operating systems, viruses, cyber attacks/dangers and URL Composition | O1 |
| K.A2 | Know the fundamentals of Networking, as the characteristics, the installation the configuration and the test of network components, the addressing system using IPv4 and Ipv6 standards, the difference among several network types, the Client/Server communication, the DNS functioning and some fundamentals about network troubleshooting | O2 |

| | | |
|--|---|----|
| K.A3a | Know the fundamentals of Python programming starting from the description of variables and types of data and arrays of data, passing through the basic condition instruction to the use of the Loop instructions and the creation of functions | O3 |
| K.A3b | Know the fundamentals of Databases in order to recognize different types of DBs, their use and their main characteristics | O3 |
| K.A5 | Know the fundamental of Electronics, taking confidence with the most used electrical quantities and the components of a electrical system, analyzing the structure of basic electrical circuits, apply the fundamental physical laws of electronics, recognize several types of electrical actuators and sensor and use measurement instruments to check a circuit | O4 |
| K.A5a | Be confident with Sustainability, knowing some energy saving techniques and alternative energy resources, how to avoid superfluous energy consumption, reduce waste and consumption of raw materials, reuse items, Minimize waste | O5 |
| K.A5b | Know the international activities and legislation to improve the sustainability in the next future | O5 |
| Moreover, by the end of the course, the students will be able to (skills): | | |
| S.A1 | Working with PC systems being able to: <ul style="list-style-type: none"> • Choose and install the Operative System • Choose and install an AntiVirus application • Check a system with an AntiVirus • Choose and install a Browser Web | O1 |
| S.A2 | Working with IT Network being able to: <ul style="list-style-type: none"> • Install and configure a network interface card • Install and configure a network switch • Install and configure a network router • Recognize Internet Protocol parameters • Configure Internet Protocol parameters • Categorize different network types • Configure the speed negotiation between NIC and Switch • Test the communication between network components • Class choose and device IP address setting • Communicate with ICMP Protocol • Recognize HTTP/HTTPS protocol characteristics • Recognize HTML characteristics | O2 |
| S.A3a | Programming Python being able to: <ul style="list-style-type: none"> • Use and configure variables • Use and configure arrays of data | O3 |

| | | |
|-------|---|----|
| | <ul style="list-style-type: none"> • Use Condition and Loop instructions • Configure and use functions | |
| S.A3b | <p>Work with a Database being able to:</p> <ul style="list-style-type: none"> • Recognize different structures of database • Use queries and report | O3 |
| S.A4 | <p>Working with basic Electronics being able to:</p> <ul style="list-style-type: none"> • Measuring electrical quantities • Connecting actuators and sensors in a electrical system • Testing of a electrical circuit | O4 |
| S.A5 | <p>Thinking about Sustainability being able to:</p> <ul style="list-style-type: none"> • Be environmentally sensitive • Identify necessary energy resources for each task • Apply environmental friendly energy resources that effectively serve the purpose of the task • Have social responsibility | O5 |

TEACHING & LEARNING METHODS

Total Hours: 40

The training methods that will be used to deliver the course are online courses at the MOOC <https://e-training.dtamproject.eu/> as well as hands-on sessions at the IoT labs.

ASSESSMENT METHODS

Self-assessment quizzes during the online courses
Exercises to run at the IoT labs

LEARNING UNITS

PC systems

- Introduction to the Personal Computer
- Basic concepts of Information Technology
- Structure of Computer
- Interfaces
- Central Processing Unit
- Input devices
- Output devices
- Memory devices Mass

- Files and Folders
- Quick memories
- Software
- Single Board Computer
- Raspberry PI

Networking

- Networks Fundamentals
- The basic elements for creating a network
- Networking Technologies Overview
- Ethernet protocol
- The correct network connections
- Network Design Questions and Answers
- Short list of key networking components

Python & Database

- Python programming fundamentals
- Python introduction
- Programming fundamentals
- Arrays
- Decisions
- Loops
- Functions

Electronics

- Electronic Fundamentals
- Electrical quantities
- Fundamental laws
- Electronic signals
- Sensors & Actuators

Sustainability

- Sustainability
- Sustainability of development: terminology, circular economy and green economy
- Conscious use of resources in technology sector: raw materials, waste and energy
- Life Cycle Assessment (LCA)

| OUTLINE | EQF level (4/5) | LOs | Week* | Estimated effort in hours |
|---|-----------------|-----|-------|---------------------------|
| 1 PC & Raspberry Pi fundamentals | 4/5 | A1 | N/A | 6h |
| 1.1 Basic concepts of Information Technology | | | | 4h |
| 1.2 Single Board Computer | | | | 2h |
| 2 Networking Fundamentals | 4/5 | A2 | N/A | 6h |
| 2.1 The basic elements for creating a network | | | | 1h |
| 2.2 Networking Technologies Overview | | | | 2h |
| 2.3 Ethernet protocol | | | | 2h |
| 2.4 Network Design Questions and Answers | | | | 1h |
| 3 Python & Database fundamentals | 4/5 | A3 | N/A | 12h |
| 3.1 IT introduction | | | | 1h |
| 3.2 Python introduction | | | | 2h |
| 3.3 Programming fundamentals | | | | 2h |
| 3.4 Program flow | | | | 2h |
| 3.5 Functions | | | | 3h |
| 3.6 Database Fundamentals | | | | 2h |
| 4 Electronic Fundamentals | 4/5 | A4 | N/A | 10h |
| 4.1 Electrical quantities | | | | 3h |
| 4.2 Fundamental laws | | | | 3h |
| 4.3 Electronic signals | | | | 2h |
| 4.4 Sensors & Actuators | | | | 2h |
| 5 Sustainability | 4/5 | A5 | N/A | 6h |

| OUTLINE | EQF level (4/5) | LOs | Week* | Estimated effort in hours |
|--|-----------------|-----|-------|---------------------------|
| 5.1 Sustainability of development: terminology, circular economy and green economy | | | | 2h |
| 5.2 Conscious use of resources in technology sector: raw materials, waste and energy | | | | 2h |
| 5.3 Life Cycle Assessment (LCA) | | | | 2h |

**As the aim of introduction is to close the gap detected using the Digital Self Evaluation Tool, the temporal sequence is not predictable..*

3.1.2 TM2: Big Data

| | |
|----------------------|---|
| COURSE NAME | Big Data |
| COURSE CODE | BD |
| DURATION | 50 hours |
| ECVET CREDITS | 2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training) |

COURSE DESCRIPTION

This course is for technicians and professionals who would like to understand the core tools used to wrangle and analyze big data, as well as the core tools used for distributed processing of large data sets across clusters of computers. Although the tools that are presented are generally applicable for data processing, analysis and visualization, the module is mainly oriented for advanced manufacturing use cases. At the end of the module, you will learn how to use Python for data analysis and data visualization. Moreover, you will learn how to use the Hadoop framework for distributed processing of large data sets.

OBJECTIVES

The course aims to present topic for:

- O1 Carrying out data collection and integrating data storage systems.
- O2 Using data processing techniques for decision making.
- O3 Working with data generated within the industrial environment, from its capture and storage to its exploitation through data processing methods.
- O4 Exploiting data to derive insights regarding the operation and maintenance of machines.
- O5 Designing the architecture of an infrastructure for the distributed processing of big data.
- O6 Communicating engaging data visualizations to support decisions towards the improvement of the digitized processes in industrial environments

LEARNING OUTCOMES

| EQF level 4 (VET) | Link to aims |
|--|--------------|
| By the end of the course, the students will get the following knowledge: | |
| K1a Big data main characteristics | O1 |
| K2a Big data at advanced manufacturing | O1 |
| K3a The data analysis process and different types of data | O1, O2 |
| K4a How to use the Jupyter Notebook to write Python programs | O1, O2 |

| | | |
|---|--|---------------|
| K5a | Main Python tools for exporting and importing data | O1, O2, O3 |
| K6a | Reading, different types of files in Python | O1, O2, O3 |
| K7a | Missing values and how to handle them with Python | O1, O2, O3 |
| K8a | Processing different types of data with Python | O1, O2, O3 |
| K9a | The NumPy package in Python for the creation of large, multi dimensional arrays and matrices | O4 |
| K10a | The Pandas library in Python for data analysis | O4 |
| K11a | The Matplotlib library in Python for data visualization | O6 |
| Moreover, by the end of the course, the students will get the following skills: | | |
| Sa1 | Preparing data for analysis using Python | O3 |
| Sa2 | Importing and Exporting Data in Python | O3 |
| Sa3 | Dealing with Missing Values in Python | O3 |
| Sa4 | Performing data preprocessing using Python | O3, O4 |
| Sa5 | Performing simple and complex data analysis using Python | O4 |
| Sa6 | Calculating basic statistics with Python | O4 |
| Sa7 | Performing data visualizations using Python | O6 |
| EQF level 5+ (HE) | | |
| By the end of the course, the students will get the following knowledge: | | |
| K1b | Main features and components of Hadoop framework | O3, O5 |
| K2b | The Hadoop Distributed File System | O3, O5 |
| K3b | The Hadoop Yarn | O3, O5 |
| K4b | The Hadoop MapReduce | O3, O5 |
| K5b | Basic administration of an Hadoop cluster | O3, O5 |
| K6b | How to develop MapReduce programs with Python | O3, O5 |
| K7b | Pig programming language | O3, O5 |
| Moreover, by the end of the course, the students will get the following skills: | | |
| S1b | Using the Hadoop framework for data storage and processing | O3, O5 |
| S2b | Using the storage (HDFS) and processing (YARN) services of Hadoop | O3, O5 |
| S3b | Using the MapReduce framework | O3, O5 |
| S4b | Submitting and managing jobs in Hadoop | O3, O5 |
| S5b | Managing key Hadoop services | O3, O5 |
| S6b | Writing simple MapReduce programs | O3, O5 |
| S7b | Writing MapReduce program with Python | O3, O5 |

TEACHING & LEARNING METHODS

Total Hours: 50

The training methods that will be used to deliver the course are online courses at the MOOC <https://e-training.dtamproject.eu/> as well as hands-on sessions at the IoT labs.

The students will use the data collected by the IoT labs for data analysis and visualization using Python. Moreover, the students will use the data collected by the IoT labs for running large-scale data processing jobs at Hadoop.

ASSESSMENT METHODS

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

LEARNING UNITS

- Introduction to Big Data
 - What is Big Data
 - Different types of data
 - Big data benefits
 - Big data applications for advanced manufacturing
 - The data analysis process and roles in data science projects
 - The data analysis process
 - Different roles in data science projects
- Introduction to Python for data analysis
 - Python installation
 - Using the Jupyter Notebook
 - Downloading files with Python
 - Main Python tools for exporting and importing data
 - Reading local files, XML files, JSON files and excel files
 - Missing values and how to handle them with Python
 - Processing of Raw Data to Tidy Data
 - Reading tabular data and large tables
 - Main libraries of Python for Data Analysis
- Python libraries for data analysis and visualization

- The NumPy library in Python for the creation of large, multi-dimensional arrays and matrices
 - The NumPy Array
 - The ndarray Class
 - Array Creation
 - Printing Arrays
 - Indexing, Slicing and Iterating
 - Shape Manipulation
- The Pandas library in Python for data analysis
 - Data Frame
 - Combine Data Frames
 - Rows and Columns Selection
 - Sorting
 - Descriptive Statistics
 - Group By
 - File I/O
- The Matplotlib library in Python for data visualization
 - Creating Basic Plots
 - Creating scatter 2D plots
 - Histograms and Density Plots
- The Apache Hadoop framework
 - Introduction to Hadoop
 - Hadoop advantages and disadvantages
 - The Hadoop Architecture and major components of Hadoop ecosystem
 - Hadoop clusters
 - Hadoop master-slave-topology
 - Single-node vs multi-node Hadoop clusters
 - Building an efficient Hadoop cluster
- The Hadoop Distributed File System
 - HDFS Architecture
 - Block replication in Hadoop
 - Rack Awareness
 - Hadoop HDFS Operations
 - Interacting with HDFS
- The Hadoop Yarn
 - Hadoop Yarn architecture

- Resource Manager
- Node Manager
- Application Master
- Interacting with YARN
- The Hadoop MapReduce
 - What is MapReduce
 - MapReduce job execution flow
 - MapReduce data processing example
 - How Hadoop runs a MapReduce job
 - Hadoop streaming
 - Running a simple MapReduce job
- Hadoop Administration
 - Common commands for Hadoop administration
- Hadoop MapReduce with Python
 - Writing a MapReduce Program in Python using the Hadoop streaming utility
 - Writing a MapReduce Program in Python using mrjob
- Hadoop and Pig
 - Pig installation
 - Pig Latin
 - Writing a Pig script
 - Running Pig scripts

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|--|--------------------|---|------|------------------------------|
| 1 Introduction to Big Data | | | | |
| 1.1 Basic concepts of Big Data | 4 | K1a, K2a, K3a, K4a | 1 | 3 |
| 1.2 Python for Data Analysis | 4 | K5a, K6a, K7a, K8a, Sa1, Sa2, Sa3, Sa4 | 1 | 3 |
| 2 Introduction to Python for data analysis | | | | |
| 2.1 The NumPy library in Python for the creation of large, multi-dimensional arrays and matrices | 4 | K9a, Sa5 | 2 | 5 |
| 2.2 The Pandas library in Python for data analysis | 4 | K10a, Sa6 | 3 | 5 |
| 2.3 The Matplotlib library in Python for data visualization | 4 | K11a, Sa7 | 3 | 4 |
| 3 The Apache Hadoop framework | | | | |
| 3.1 Basic concepts of Apache Hadoop | 5 | K1b | 4 | 4 |
| 3.2 The Hadoop Distributed File System | 5 | K2b, S1b, S2b | 4 | 4 |
| 3.3 The Hadoop Yarn | 5 | K3b, S2b, S3b | 5 | 4 |
| 3.4 The Hadoop MapReduce | 5 | K4b, S3b | 5 | 4 |
| 3.5 Hadoop Administration | 5 | K5b, S5b | 6 | 4 |
| 3.6 Hadoop MapReduce with Python | 5 | K6b, S6b, S7b | 6 | 4 |
| 3.7 Hadoop and Pig | 5 | K7b, S8b | 7 | 6 |

3.1.3 TM3: Machine Learning

| | |
|----------------------|------------------|
| COURSE NAME | Machine Learning |
| COURSE CODE | ML |
| DURATION | 50 hours |
| ECVET CREDITS | 2 credits |

| COURSE DESCRIPTION |
|---|
| <p>This course is for technicians and professionals who would like to understand the core tools used to implement machine learning techniques and analyze the shop floor data based on regression, classification, and clustering in order to train the systems for improved operations. The presented tools are the basic techniques and types of machine learning, the algorithms and the methods for it and their basic implementation in Python programming language. At the end of the module, one will learn the theoretics of machine learning, classification, regression, and clustering analysis. Moreover, the practical background with Python libraries and implementation will be covered by the modules.</p> |

| OBJECTIVES | |
|--------------------|---|
| This unit aims to: | |
| O1 | Understand the fundamental concepts and principles of machine learning |
| O2 | Gain practical knowledge and skills in implementing regression, classification, and clustering techniques |
| O3 | Learn to analyze and interpret data using machine learning algorithms |
| O4 | Apply machine learning models to real-world industrial scenarios |
| O5 | Develop the ability to prepare and preprocess data for machine learning analysis |
| O6 | Familiarize oneself with various supervised and unsupervised learning techniques |
| O7 | Gain insights into advanced manufacturing applications of machine learning |

| LEARNING OUTCOMES | | |
|--|--|--------------|
| EQF level 4 (VET) | | Link to aims |
| By the end of the course, the students will get the following (knowledge): | | |
| K1a | Understanding of the theoretical principles of machine learning | O1 |
| K2a | Understanding Machine Learning categories | O2 |
| K3a | Knowledge of basic machine learning techniques such as regression, classification, and clustering. | |

| | | |
|--|---|--------|
| K4a | Familiarity with different types of machine learning, including supervised and unsupervised learning. | O6 |
| K5a | Understanding of linear and non-linear regression models. | O3 |
| K6a | Knowledge of classification and clustering techniques and their implementation in Python. | O6 |
| K7a | Awareness of advanced manufacturing applications of machine learning. | O4, O7 |
| K8a | Understanding of data analysis and interpretation using machine learning algorithms. | O3 |
| Moreover, by the end of the course, the students will be able to (skills): | | |
| Sa1 | Acquire the ability to prepare and preprocess data for machine learning analysis using Python. | O5 |
| Sa2 | Develop the skills to implement machine learning models using Python libraries. | O4 |
| EQF level 5+ (HE) | | |
| By the end of the course, the students will gain (knowledge): | | |
| K1b | In-depth understanding of advanced machine learning concepts, algorithms, and methodologies. | O1 |
| K2b | Knowledge of advanced regression techniques, including linear, non-linear, and polynomial regression, and their implementation in Python. | O3 |
| K3b | Knowledge about ensemble methods such as random forests, AdaBoost, Bagging Classifier etc | O3 |
| K4b | Knowledge regarding the definition, applications, advancements, interpretability challenges, and empirical nature of deep learning. | O3 |
| K5b | Knowledge of unsupervised learning techniques such as dimensionality reduction, anomaly detection, and recommendation systems. | O6 |
| K6b | Proficiency in feature engineering and feature selection techniques to optimize machine learning models. | O6 |
| Moreover, by the end of the course, the students will be able to (skills): | | |
| Sb1 | Acquire the skills to design and implement complex machine learning models using advanced algorithms. | O4 |

| | |
|--|-------------------|
| TEACHING & LEARNING METHODS | Total Hours: 50 h |
| Lectures 30 h | |
| Practical sessions and exercises 10 h | |
| Case studies discussions 10 h | |

ASSESSMENT METHODS

- Self-assessment quizzes during the online courses
- Exercises covering basic and advanced machine learning concepts, including dataset handling, model training and evaluation, data plotting, and real-life problem solving.
- Challenges involving interacting with real-world data, visualizing and preprocessing it, selecting an appropriate model, building and training it, evaluating the results, and documenting the process.

LEARNING UNITS

- Machine Learning Introduction
 - Definition
 - Machine Learning Categories
 - How it's made
 - Why insist on Machine Learning though?
 - Examples of machine learning use
 - Machine Learning advantages and disadvantages
 - Machine Learning for manufacturing applications
 - Global market examples
- Supervised Learning
 - What is supervised learning?
 - Mapping to real life Manufacturing Cases
 - Types of supervised learning
 - K Nearest Neighbor (kNN)
 - Advantages and disadvantages of Supervised Learning
- Python Unsupervised Learning
 - What is unsupervised learning?
 - Types of unsupervised learning
 - Unsupervised learning advantages
 - Unsupervised learning disadvantages
 - Classification vs clustering in machine learning
- Machine Learning - Regression with Python for ML
 - Linear Regression with Python
 - Multiple Linear Regression with scikit-learn
 - Polynomial Regression with Python

- Advanced Linear Regression with statsmodel
- Cost Function in the Linear Regression
- Classification and Decision trees in Python
 - Let's get started
 - Find the k nearest neighbors
 - Decision Trees in Python
 - Comparison of Decision Trees and KNN

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|---|--------------------|-------------------------|----------|------------------------------|
| 1 Unit 1: Machine Learning - Introduction | | | | 4h |
| 1.1 Definition | 4/5 | K1a | 1 | 20min |
| 1.2 Machine Learning Categories | 4/5 | K2a | 1 | 20min |
| 1.3 How it's made | 4/5 | K1a | 1 | 20 min |
| 1.4 Why insist on Machine Learning though? | 4/5 | K1a | 1 | 1h |
| 1.5 Examples of machine learning use | 4/5 | K1a | 1 | 20min |
| 1.6 Machine Learning advantages and disadvantages | 4/5 | K1a | 1 | 20min |
| 1.7 Machine learning for manufacturing applications | 4/5 | K1a, K4b | 1 | 1h |
| 1.8 Global market examples | 4/5 | K1a, K7a | 1 | 20min |
| 2 Unit 2: Supervised Learning | | | 1 | 10h |
| 2.1 What is supervised Learning? | 4/5 | K1a, K2a, K4a | 1 | 20min |
| 2.2 Mapping to real life Manufacturing Cases | 4/5 | K1a, K3a, K4a, K5a, K7a | 1 | 20min |
| 2.3 Types of supervised learning | 4/5 | K1a, K2a, K4a, K3b | 1 | 6h |
| 2.4 K Nearest Neighbor (kNN) | 4/5 | K3a, K4a, K5a | 2 | 3h |
| 2.5 Advantages and disadvantages of Supervised Learning | 4/5 | K3a, K4a, K5a, K4b | 2 | 20min |
| 3 Unit 3: Unsupervised Learning | | | | 10h |
| 3.1 What is unsupervised Learning? | 4/5 | K3a, K4a, K5a | 2 | 20min |
| 3.2 Types of unsupervised learning | 4/5 | K3a, K4a, K5a, K5b | 3 | 8h |
| 3.3 Unsupervised learning advantages | 4/5 | K3a, K4a, K5a | 3 | 20min |
| 3.4 Unsupervised learning disadvantages | 4/5 | K3a, K4a, K5a | 4 | 20min |
| 3.5 Classification vs clustering in machine learning | 4/5 | K3a, K4a, K5a K6a, K5b | 4 | 1h |
| 4 Unit: Machine Learning – Regression with Python for ML | | | | 16h |

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|---|--------------------|---------------------------------|------|------------------------------|
| 4.1 Linear Regression with Python | 4/5 | K3a, K4a, K5a, K1b, Sa1, K8a | 4 | 3h |
| 4.2 Multiple Linear Regression with scikit-learn | 4/5 | K8a, K1b, Sa1, Sa2 | 5 | 3h |
| 4.3 Polynomial Regression with Python | 4/5 | K8a, K1b, Sa1 Sa2 | 5 | 3h |
| 4.4 Advanced Linear Regression with statsmodel | 5 | K6b, K1b, Sa1 Sa2 | 5 | 3h |
| 4.5 Cost Function in the Linear Regression | 5 | K6b, K1b, Sa1 Sa2, , Sb1 | 6 | 4h |
| 5 Unit Classification and Decision trees in Python | | | | 10h |
| 5.1 Let's get started | 4/5 | K6b, Sa1, Sa2, Sb1 | 6 | 3h |
| 5.2 Find the k nearest neighbors | 4/5 | K6b, Sa1, Sa2, Sb1 | 7 | 3h |
| 5.3 Decision Trees in Python | 4/5 | K6b, Sa1, Sa2, Sb1 | 7 | 3h 50min |
| 5.4 Comparison of Decision Trees and KNN | 4/5 | K6b, Sa1, Sa2, Sb1 | 7 | 10min |

3.1.4 TM3: Advanced Sensors

| | |
|----------------------|---|
| COURSE NAME | Advanced Sensors |
| COURSE CODE | SC |
| DURATION | 50 hours |
| ECVET CREDITS | 2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training) |

COURSE DESCRIPTION

The sensors module will enable learners to use different kinds of sensors on common devices (arduino, raspberry PI) and connect to a dashboard or message queue. The module uses Python as a programming language of choice, expanding on the Python fundamentals in module 1.

OBJECTIVES

This unit aims to:

- O1 Choosing appropriate sensors for a problem domain.
- O2 Choose suitable sensing device based on problem criteria
- O3 Assemble smart devices and sensors into a working prototype.
- O4 Use wireless or wired communication to data storage/processing
- O5 Use Python to gather sensor data and send to processing devices/database/queue.
- O6 Visualize data into dashboards, warning systems, reports or actuators

LEARNING OUTCOMES

| EQF level 4 (VET) and EQF level 5 (HE) | | Link to aims |
|---|---|--------------|
| By the end of the course, the students will get the following knowledge: | | |
| K1 | Different types of sensors | O1 |
| K2 | Sensor devices characteristics and differences | O2 |
| K3 | Steps to assemble prototypes with sensors | O3 |
| K4 | Wired communication protocols | O4 |
| K5 | Wireless communication protocols | O4 |
| K6 | Python commands and common libraries for communicating with sensors and communicate over networks | O5 |
| K7 | Different visualization systems characteristics and differences | O6 |
| Moreover, by the end of the course, the students will get the following skills: | | |
| S1 | Assembling and troubleshooting hardware prototype using Arduino IDE | O1,O2,O3 |
| S2 | Importing Python libraries for common sensors | O5 |

| | | |
|----|---|--------|
| S3 | Write Python code to send sensor data to a MQTT queue | O5, O6 |
| S4 | Write Python code to send data to a MySQL database | O5 |
| S5 | Assemble and troubleshoot Raspberry PI with sensors | O3 |
| S6 | Query MySQL database from Python code | O4, O5 |
| S7 | Connect a dashboard to display sensor data | O6 |

| TEACHING & LEARNING METHODS | Total Hours: 50 |
|--|-----------------|
| <p>The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs. The students will listen to lecturers showing different approaches to solve problems, and demonstrate different sensors and devices. In the labs, different raspberry PI's and Arduino's are used to build prototypes. Students will work together in groups in a final challenge. The module can also be used to do exams for a certificate for module "K0730 programming microcontrollers", which is a part of the programs "IT Systems and devices" and "software developer" in The Netherlands.</p> | |

| ASSESMENT METHODS |
|--|
| <ul style="list-style-type: none"> ● Self-assessment quizzes during the online courses ● Exercises to run at the IoT labs ● Challenges to run at the IoT labs |

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|---|------------------|--------------|----------|---------------------------|
| 1. Introduction to Advanced Sensors | 4 & 5 | | 1 | 4 |
| 1.1 Introduction | 4 & 5 | O1,O2 | 1 | 0,5 |
| 1.2 What is a sensor? | 4 & 5 | O1, K1a | 1 | 0,5 |
| 1.3 IOT Networking | 4 & 5 | O4, K4a, K5a | 1 | 0,5 |
| 1.4 System and application software | 4 & 5 | O5, K6 | 1 | 0,5 |
| 1.5 Connections to the web | 4 & 5 | K4, K5 | 1 | 0,5 |
| 1.6 Data storage | 4 & 5 | O2 | 1 | 0,5 |
| 1.7 Linux | 4 & 5 | O2 | 1 | 0,5 |
| 1.8 Quiz | 4 & 5 | O2, K2 | 1 | 0,5 |
| 2. Sensors | 4 & 5 | | 2 | 12 |
| 2.1 Overview | 4 & 5 | O2 | 2 | 0,5 |
| 2.2 Temperature / Humidity / Air pressure / Gas sensors | 4 & 5 | O1, K1, K2 | 2 | 1 |
| 2.3 Motion sensors | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.4 Navigation modules | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.5 Raspberry Pi Sensors – Wireless / Infrared (IR) / Bluetooth | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.6 Motors | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.7 Analogue Raspberry Pi Sensors | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.8 Power/Current Supply | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.9 Displays | 4 & 5 | O1, K1, K2 | 2 | 0,5 |
| 2.10 Other modules, components and Raspberry Pi Sensors | 4 & 5 | O1, K1, K2 | 2 | 0,75 |

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|--|------------------|--------------------------------|----------|---------------------------|
| 2.11 Quiz | 4 & 5 | O1, K1, K2 | 2 | 0,25 |
| 2.12 Exercise 1: Reading Out RFID RC522 Tags (NFC) | 4 & 5 | O3, O5, K3, S1, S2, S4, S5 | 3 | 2 |
| 2.13 Exercise 2: Controlling an HD44780 LCD display via I2C | 4 & 5 | O3, O5, K3, S1, S2, S4, S5 | 3 | 2 |
| 2.14 Exercise 3: Using a distance sensor (ultrasonic sensor HC-SR04) | 4 & 5 | O3, O5, K3, S1, S2, S4, S5 | 3 | 2 |
| 3. Using a device to work with sensors | 4 & 5 | | 4 | 4 |
| 3.1 Using a device to work with sensors | 4 & 5 | O2, K2, S1 | 4 | 1 |
| 3.2 Arduino Uno R3 | 4 & 5 | O2, K2, S1 | 4 | 1 |
| 3.3 Raspberry Pi 4 and Raspberry 3B+ | 4 & 5 | O2, K2, S1 | 4 | 1 |
| 3.4 Quiz | 4 & 5 | | 4 | 1 |
| 4. Programming IoT with Python on a Raspberry Pi | 4 & 5 | | 5 | 16 |
| 4.1 Using Python as IoT programming language | 4 & 5 | O5, K6 | 5 | 0,5 |
| 4.2 Arguments for using Python for IoT | 4 & 5 | O5 | 5 | 0,5 |
| 4.3 Book: "The Coder's Apprentice" by Pieter Spronck | 4 & 5 | O5, K6, S1, S2, S3, S4, S5, S6 | 5, 6 | 12 |
| 4.4 Project: physical computing by Raspberry Pi Foundation | 4 & 5 | O5, K6, S1, S2, S3, S4, S5, S6 | 7 | 1 |
| 4.5 Exercise: operating a "traffic light" from Python code | 4 & 5 | O5, K6, S1, S2, S3, S4, S5, S6 | 7 | 2 |
| 5. Wired communication | 4 & 5 | | 8 | 2 |
| 5.1 KNX | 4 & 5 | O4, K4 | 8 | 1 |

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|---|------------------|----------------|----------|---------------------------|
| 5.2 PLC | 4 & 5 | O4, K4 | 8 | 1 |
| 6. Wireless communication | 4 & 5 | | 8 | 4 |
| 6.1 Wi-Fi | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.2 LoRa | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.3 Bluetooth | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.4 4G/5G Cellular networks | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.5 433MHz | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.6 Z-Wave | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.7 Zigbee | 4 & 5 | O4, K5 | 8 | 0,5 |
| 6.8 Quiz | 4 & 5 | | 8 | 0,5 |
| 7 Data visualisation platforms | 4 & 5 | | 9 | 8 |
| 7.1 Data visualisation with Grafana | 4 & 5 | O6, K7, S7, S6 | 9 | 1 |
| 7.2 Open platform for interacting sensors (Home Assistant) | 4 & 5 | O6, K7, S7, S6 | 9 | 1 |
| 7.3 Processing data with NodeRed | 4 & 5 | O6, K7, S7, S6 | 9 | 2 |
| 7.4 Exercise: Connection of Siemens PLC to Raspberry PI & NodeRed | 4 & 5 | O6, K7, S7, S6 | 9 | 4 |

3.1.5 TM4: Cybersecurity

| | |
|----------------------|---|
| COURSE NAME | Cybersecurity |
| COURSE CODE | Cyb |
| DURATION | 50 hours during 6 weeks |
| ECVET CREDITS | 2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training) |

| COURSE DESCRIPTION |
|---|
| This course is for technicians and professionals who would like to define and implement security strategies in industrial organizations and infrastructures. At the end of the module you will learn how to perform cybersecurity diagnostics, identifying vulnerabilities and implementing the necessary measures to mitigate them, applying the necessary measures to mitigate them by applying the current regulations and industry standards, following the sector standards, following the protocols of quality, occupational risk prevention and environmental respect. |

| OBJECTIVES |
|---|
| This unit aims to: |
| O1 Make the students familiar with the fundamentals of industrial cybersecurity |
| O2 Understand the cybersecurity implications in Advanced Manufacturing Industry |
| O3 Define a cyber secure architecture for Smart Factories |
| O4 Present the most important cyber threats for Smart Factories |
| O5 Explain what are the most important cybersecurity measures and techniques |
| O6 Present what is a cybersecurity diagnosis report |

| LEARNING OUTCOMES | |
|---|---------------------|
| EQF level 4 (VET) | Link to aims |
| By the end of the course, the students will get the following knowledge: | |
| K1a Understanding of the changes needed for the IT /OT convergence | O1 |
| K2a Basic understanding of industrial control systems (ICS) | O2,O3 |
| K3a Types of cybersecurity hazards | O4 |
| K4a Types of credentials and access control systems (Digital signatures...) | O5 |
| K5a Main concepts of zoning and segmentation in ICS | O4, O5 |
| K6a Basic principles of data security | O5 |
| K7a Basic principles of access controls | O5 |

| | | |
|---|--|--------|
| K8a | Basic principles of secure coding | 05 |
| Moreover, by the end of the course, the students will get the following skills: | | |
| Sa1 | Segment an industrial network | 03, 05 |
| Sa2 | Identify people, devices and systems | 05 |
| Sa3 | Propose solutions for secure remote access | 04,05 |
| Sa4 | Propose solutions for secure industrial communications | 04,05 |
| Sa5 | Propose solutions for data security | 04,05 |
| EQF level 5+ (HE) | | |
| By the end of the course, the students will get the following knowledge: | | |
| K1b | Understanding of the changes needed for the IT /OT convergence | 01 |
| K2b | Basic understanding of industrial control systems (ICS) | 02,03 |
| K3b | Industrial communication networks and protocols | 02 |
| K4b | Types of cybersecurity hazards | 04 |
| K5b | Types of credentials and access control systems (Digital signatures...) | 05 |
| K6b | Main concepts of zoning and segmentation in ICS | 04, 05 |
| K7b | Know what is the vulnerability management system (CVE...) | 05 |
| K8b | Main industry standards and applicable regulations related to cybersecurity | 03 |
| K9b | Main features of cybersecurity policies and measures | 03, 05 |
| K10b | Network control and supervision devices for secure communications in ICS (IDS, IPS...) | 05 |
| K11b | Basic principles of data security | 05 |
| K12b | Basic principles of access controls | 05 |
| K13b | Basic principles of secure coding | 05 |
| K14b | Relevant information for cybersecurity reports | 06 |
| Moreover, by the end of the course, the students will get the following skills: | | |
| S1b | Analyze IT and OT environments | 02,03 |
| S2b | Implement IT/OT network coupling | 02,03 |
| S3b | Segment an industrial network | 03,05 |
| S4b | Search for information on known vulnerabilities in industrial control systems. | 04 |
| S5b | Identify Vulnerabilities | 04 |
| S6b | Identify people, devices and systems | 04, 05 |
| S7b | Identify the cybersecurity main policies in an organization | 03,05 |
| S8b | Analyze the features of the communication protocols | 03,05 |
| S9b | Propose solutions for secure remote access | 04,05 |
| S10b | Propose solutions for secure industrial communications | 04,05 |
| S11b | Apply Intrusion detection systems (IDS) | 04,05 |

| | | |
|------|---|-------|
| S12b | Apply standards for secure communications | O4,O5 |
| S13b | Propose solutions for data security | O4,O5 |

TEACHING & LEARNING METHODS

Total Hours: 50

The training methods that will be used to deliver the course are online courses at the MOOC <https://e-training.dtamproject.eu/> as well as hands-on sessions at the IoT labs.

Students will perform a network discovery test with the available informatic tools in order to inventory the existing equipment. The available equipment could be industrial PLC's and HMI's, different type of devices (raspberry, Arduino, different sensors...) and servers. The connexions should be secured using tools such as VPN and digital signatures/certificates. The Students will create a cybersecurity policy to improve the system.

ASSESMENT METHODS

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|---|-----------------|---|------|---------------------------|
| 1 IT/OT environment features | | | | |
| 1.1 Definition of IT/OT | 4/5 | K1a, K2a | 1 | 2 |
| 1.2 Cybersecurity for IT/OT integration | 4/5 | K1a, K1b | 1 | 2 |
| 2 Risk Scenarios | | | | |
| 2.1 Types of ICS | 4/5 | K2a, K2b, K3b | 1 | 2 |
| 2.2 Physical and logical network architecture | 4/5 | K2a, K2b, K3b | 2 | 4 |
| 2.3 Types of hazards | 4/5 | K3a, K4b, S5b | 2 | 4 |
| 2.4 External risks and cyberattacks | 4/5 | K3a, K4b, S5b | 3 | 4 |
| 2.5 Common vulnerabilities and exposures | 5 | K7b, S4b, S5b | 3 | 1 |
| 3 Cybersecurity policies | | | | |
| 3.1 Industry standards and regulations | 5 | K8b, S7b | 3 | 2 |
| 3.2 Cybersecurity policies | 5 | K9b, S7b | 3 | 4 |
| 4 Securing industrial networks | | | | |
| 4.1 Zoning and segmentation | 4/5 | K5a, S1a, K6b, S1b, S2b, S3b | 4 | 4 |
| 4.2 secure communications | 4/5 | K6a, S2a, S3a, S4a, K10b, S1b, S2b, S6b, S8b, S9b, S10b, S12b | 4 | 6 |
| 4.3 Data security | 4/5 | K6a, S5a, K11b, S10b, S13b | 5 | 4 |
| 4.4 Access control and credentials | 4/5 | K4a, K7a, K5b, K12b, S6b | 5 | 2 |
| 4.5 Secure coding | 4/5 | K8a, K13b | 5 | 1 |
| 5 Securing industrial networks | | | | |
| 5.1 Anomaly monitoring and detection | 5 | K10b, S11b | 6 | 3 |

| OUTLINE | EQF level (4/5) | LOs | Week | Estimated effort in hours |
|---|--------------------|------------|------|------------------------------|
| 5.2 IDS, IPS and SIEM tools | 5 | K10b, S11b | | 2 |
| 6 Cybersecurity reports | | | | |
| 6.1 Cybersecurity diagnosis and reports | 5 | K14b | 6 | 3 |

3.1.6 TM6: Transversal Competences

| | |
|----------------------|-------------------------|
| COURSE NAME | Transversal Competences |
| COURSE CODE | TM6 |
| DURATION | 25 hours |
| ECVET CREDITS | 1 |

COURSE DESCRIPTION

This course is for technicians and professionals who would like to access and improve the learning process in a different and pioneering way. At the end of the module, on a personal level students will have the ability to achieve individual learning, adapt to different situations, find innovative ideas, and surpass difficulties. It is well known that a strong and complete personality is the first step on professional success. Furthermore, on a social level you will be able to communicate with other people and cooperate properly. Finally, students will enrich their knowledge with the ability to handle big information volume effectively.

OBJECTIVES

This unit aims to:

- O1 Provide the tools and information for self-learning
- O2 Enable students to enhance their critical thinking, flexibility, and adaptability to new situations, through methods, procedures, and techniques to increase the effectiveness of changes.
- O3 Enhance problem-solving competences
- O4 Empower communication skills, team working and cooperation through strategies and principles on creating strong teams.
- O5 Empower leadership skills, handling responsibilities and decisions
- O6 Enhance the value of respect and interculturalism
- O7 Strengthen the ability to collect and analyse information, controlling their validity
- O8 Offer the tools and knowledge for effective project management, risk assessment and project closure.

| LEARNING OUTCOMES | | |
|--|---|--------------|
| EQF level 4 (VET) | | Link to aims |
| By the end of the course, the students will (knowledge): | | |
| K.A1 | Learn by doing, capitalizing new knowledge and new opportunities to learn whilst critically assessing the resources. Have deeper knowledge of an effective self-learning process, have the tools to boost creativity and use them for upskilling and finding new opportunities. | O1 |
| K.A2 | Have knowledge on ways to make successful changes, being flexible in their professional and personal lives, collaborate successfully and don't be afraid to take necessary risks. Have a deeper knowledge on critical thinking and its components, know the abilities of critical thinkers and be able to apply them in order to ensure innovation and progress. | O1,O2 |
| K.A3 | Have knowledge on problem solving techniques, research and analytical skills, understand the steps of effective problem-solving processes. Understand creativity techniques and know how to apply them. | O3 |
| K.A4 | Know how to use effective communication methods and skills in their professional and personal life. Have deeper knowledge on methods of communication, active listening and the set of principles to achieve effective communication processes. Through this they will also know the importance of cooperation and teamwork, as well as strategies to create well-balanced teams. | O4 |
| K.A5 | Know the characteristics of a good leader and understand the importance of having a strong team. Have deeper knowledge and understanding of leadership and the characteristics of a successful leader. They will know the importance of taking initiatives as well as ways to lead their team. | O5 |
| K.A6 | Know the value of different cultures and appreciate interculturalism, through mutual respect. Have deeper knowledge on the essence of interculturalism which is necessary in the professional world today, forms and elements of intercultural communication and ways to avoid any occurring obstacles to intercultural collaboration and communication. | O6 |
| K.A7 | Know how to collect and analyse information. Have deeper knowledge on information and data analysis, types of information analysis and data analysis and control the reliability of information and resources. | O7 |
| K.A8 | Know what a project consists of, and how to effectively manage a project from the beginning to its end. Have deeper knowledge on project management, know the project's lifecycle, planning and implementation. They will also acquire knowledge regarding risk analysis, and planning tools that help guide the organizational action steps related to projects. | O8 |
| Moreover, by the end of the course, the students will be able to (skills): | | |

| | | |
|--|---|----|
| S.A1 | Have communication skills, presentation skills, verbal and written communication skills, empathy and open mindedness. Collaboration skills/ Team Management Skills/ Networking skills/ Stress Management Skills/ Negotiation Skills/ Conflict Resolution Skills | O1 |
| S.A2 | Have skills on identification and definition of problems. Research skills Analytical skills | O2 |
| S.A 3 | Have the skills to resolve problems, using their creativity and critical thinking | O3 |
| S.A 4 | Have the skills to effectively communicate in their personal and professional lives. | O4 |
| S.A5 | Have the skills to become good leaders and create strong teams around them. | O5 |
| S.A 6 | Have the skills to work and collaborate with people from different cultures. | O6 |
| S.A 7 | Have the skills to collect and analyse information, and check their validity. | O7 |
| S.A 8 | Have skills to manage projects from the beginning to their finalization. They will have planning skills, risk assessment skills which are crucial in project management. | O8 |
| EQF level 5+ (HE) | | |
| By the end of the course, the students will (knowledge): | | |
| K.B 1 | Learn by doing, capitalizing new knowledge and new opportunities to learn whilst critically assessing the resources. Have deeper knowledge of an effective self-learning process, have the tools to boost creativity and use them for upskilling and finding new opportunities. | O1 |
| K.B2 | Have knowledge on ways to make successful changes, be flexible in their professional and personal lives, collaborate successfully and don't be afraid to take necessary risks. Have a deeper knowledge on critical thinking and its components, know the abilities of critical thinkers and be able to apply them in order to ensure innovation and progress. | O2 |
| K.B3 | Have knowledge on problem solving techniques, research and analytical skills, understand the steps of effective problem-solving processes. Understand creativity techniques and know how to apply them. | O3 |
| K.B4 | Know how to use effective communication methods and skills in their professional and personal life. Have deeper knowledge on methods of communication, active listening and the set of principles to achieve effective communication processes. Through this they will also know the importance of | O4 |

| | | |
|--|--|-----------------|
| | cooperation and teamwork, as well as strategies to create well-balanced teams. | |
| K.B5 | Know the characteristics of a good leader and understand the importance of having a strong team. Have deeper knowledge and understanding of leadership and the characteristics of a successful leader. They will know the importance of taking initiatives as well as ways to lead their team. | O2,O3, O4,O5 |
| K.B6 | Know the value of different cultures and appreciate interculturalism, through mutual respect. Have deeper knowledge on the essence of interculturalism which is necessary in the professional world today, forms and elements of intercultural communication and ways to avoid any occurring obstacles to intercultural collaboration and communication. | O6 |
| K.B7 | Know how to collect and analyse information. Have deeper knowledge on information and data analysis, types of information analysis and data analysis and control the reliability of information and resources. | O7 |
| K.B8 | Know what a project consists of, and how to effectively manage a project from the beginning to its end. Have deeper knowledge on project management, know the project's lifecycle, planning and implementation. They will also acquire knowledge regarding risk analysis, and planning tools that help guide the organizational action steps related to projects. | O4, O5,O8 |
| Moreover, by the end of the course, the students will be able to (skills): | | |
| S.B1 | They will have the skills to: critically analyze situations Change strategies and mindset to adapt to new situations/ critically analyze former strategies and their application to new situations/ Create new strategies/ Innovation Thinking Identification and definition of problems Research skills Analytical skills Break down the issue to its critical components. Create alternative solutions. Evaluate alternative solutions. Risk assessment skills | O1 |
| S.B2 | Advising/ coaching/ conflict resolution/ decision making/ diplomacy/ team spirit/ cooperation Acceptability/ globalization/ broad reach of interests Analytical Skills Identification of critical components of an issue Critical Thinking towards information Planning and Organizing Skills Goal setting and Management skills | O2 |

| | | |
|-------|---|---------------------|
| S.B 3 | Have skills on problem solving techniques, research and analytical skills, understand the steps of effective problem-solving processes. Skills to apply creativity techniques in their professional and personal life. | O3 |
| S.B 4 | Skills to use effective communication methods in their professional and personal life. Have deeper knowledge on methods of communication, and the skills to actively listen. Through this they will also gain the skills of cooperation and teamwork, as well as strategies to create well-balanced teams. | O4 |
| S.B5 | Skills and characteristics of a good leader and the skills to create a strong team. They will have the skills to take initiatives as well as ways to lead their team. | O3, O4,O5 |
| S.B6 | Skills to appreciate interculturalism, through mutual respect. Skills to appreciate the essence of interculturalism which is necessary in the professional world today, forms and elements of intercultural communication and ways to avoid any occurring obstacles to intercultural collaboration and communication. | O6 |
| S.B7 | Skills to collect and analyse information, data analysis, types of information analysis and data analysis and the skills to control the reliability of information and resources. | O7 |
| S.B8 | Skills to effectively manage a project from the beginning to its end. Skills to become effective project managers. Skills on project management, understanding the project's lifecycle, planning and implementation. They will also acquire skills regarding risk analysis, and planning tools that help guide the organizational action steps related to projects. | O3, O4,O5, O8 |

| | |
|---|-----------------|
| TEACHING & LEARNING METHODS | Total Hours: 25 |
| <p>The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/</p> <ul style="list-style-type: none"> • Self-assessment quizzes during the online courses • Exercises to run at the IoT labs • Challenges to run at the IoT labs | |

| |
|-----------------------|
| LEARNING UNITS |
| Self-learning |

- Definition of the term
- Benefits of self-learning
- 1.3 Seven steps for an effective self-learning process
- 1.4 The six C' s of Self Learning
- Self-learning after the pandemic
- 1.6 Self-learning as a tool to boost creativity
- 1.7 Self-learning as a tool for upskilling and new opportunities
- 1.8 Self-learning as a supporting mechanism for developing other transversal skill

Flexibility & Critical Thinking

- 2.1 Flexibility and Adaptability
- 2.2 Flexibility and adaptability to new situations
- 2.3 Characteristics of an adaptable and flexible person
- 2.4 Ways to make successful changes
- 2.5 Methods, procedures, and techniques to increase the effectiveness of changes
- 2.6 Critical and Innovative Thinking
- 2.7 Process of critical thinking
- 2.8 The components of critical thinking
- 2.9 Critical thinking abilities
- 2.10 The meaning of innovative thinking
- 2.11 Ten ways to develop innovative ideas

Problem Solving

- 3.1 Problem Solving definition
- 3.2 Why are problem solving skills essential today
- 3.3 Problem-solving skills
- 3.4 Problem solving as a complex mental process
- 3.5 Nine steps of an effective problem-solving process
- 3.6 Creativity techniques
- 3.7 Creative Problem Solving
- 3.8 SCAMPER

Communication and Cooperation

- 4.1 Definition of the term
- 4.2 Methods of communication
- 4.3 Why are communication skills so important today?
- 4.4 Effective communication
- 4.5 Main set of principles to achieve effectiveness in communication

- 4.6 Cooperation-Team Working
- 4.7 Definition of Cooperation
- 4.8 Which are the benefits of an effective collaboration, especially after the stress caused by the COVID-19 pandemic
- 4.9 Strategies to create a well-balanced and efficient team

Leadership

- 5.1 Definition of leadership
- 5.2 The complexity of leadership
- 5.3 Taking charge of initiatives
- 5.4 The characteristics of a successful leader
- 5.5 Effective ways to lead your team

Globalization

- 6.1 Intercultural understanding
- 6.2 Basic forms and elements of intercultural communication
- 6.3 Different cultures and ways of thinking
- 6.4 Obstacles to an effective intercultural communication
- 6.5 How to improve your intercultural skills
- 6.6 Value of acceptance

Information and data analysis

- 7.1 Information analysis
- 7.2 Types of Information analysis
- 7.3 Data analysis
- 7.4 Information vs Data
- 7.5 Types of data analysis
- 7.6 Control reliability of information

Project Management

- 8.1 Project and Project Management definition
- 8.2 Project Lifecycle
- 8.3 Project Planning and Implementation
- 8.4 Risk analysis
- 8.5 Planning tools
- 8.6 The importance of communication
- 8.7 Change of management
- 8.8 Necessary steps for a successful change management process

| OUTLINE | EQF level (4/5) | LOs | Estimated effort in hours |
|---|-----------------|---|---------------------------|
| Module 1: Self-learning | 4/5 | EQF LEVEL 4/5 | 3 |
| 1.1 Definition of the term | 4/5 | KA.1, KB.1,SA.1,SB.1 | 20 min |
| 1.2 Benefits of self-learning | 4/5 | KA.1,KB.1, SA.1,SB.1 | 20 min |
| 1.3 Seven steps for an effective self-learning process | 4/5 | KA.1,KB.1, SA.1,SB.1 | 30 min |
| 1.4 The six C' s of Self Learning | 4/5 | KA.1,KB.1, SA.1,SB.1 | 20 min |
| 1.5 Self-learning after the pandemic | 4/5 | KA.1,KB.1, SA.1,SB.1 | 20 min |
| 1.6 Self-learning as a tool to boost creativity | 4/5 | KA.1,KB.1, SA.1,SB.1 | 30 min |
| 1.7 Self-learning as a tool for upskilling and new opportunities | 4/5 | KA.1,KB.1, SA.1,SB.1 | 20 min |
| 1.8 Self-learning as a supporting mechanism for developing other transversal skills | 4/5 | KA.1,KB.1, SA.1,SB.1 | 20 min |
| Module 2: Flexibility & Critical Thinking | 4/5 | EQF LEVEL 4/5 | 3 |
| 2.1 Flexibility and Adaptability | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.2 Flexibility and adaptability to new situations | 4/5 | KA.1,KB.1, SA.1,SB.2.,KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.3 Characteristics of an adaptable and flexible person | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.4 Ways to make successful changes | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |

| OUTLINE | EQF level (4/5) | LOs | Estimated effort in hours |
|--|-----------------|---|---------------------------|
| 2.5 Methods, procedures, and techniques to increase the effectiveness of changes | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 20 min |
| 2.6 Critical and Innovative Thinking | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.7 Process of critical thinking | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.8 The components of critical thinking | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 20 min |
| 2.9 Critical thinking abilities | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.10 The meaning of innovative thinking | 4/5 | KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2 | 15 min |
| 2.11 Ten ways to develop innovative ideas | 4/5 | KA.1,KB.1, SA.1,SB.1,KA.2,KB.2,S.A.2,S.B.2 | 20 min |
| Module 3: Problem Solving | 4/5 | EQF LEVEL 4/5 | 3 |
| 3.1 Problem Solving definition | 4/5 | K.A3, K.B3,S.A3,S.B3 | 20 min |
| 3.2 Why are problem solving skills essential today | 4/5 | K.A3, KB.3,S.A3,S.B3 | 20 min |
| 3.3 Problem-solving skills | 4/5 | K.A1, K.B1, K.A3, K.B3, S.A3,S.B3 | 20 min |
| 3.4 Problem solving as a complex mental process | 4/5 | K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3 | 25 min |
| 3.5 Nine steps of an effective problem-solving process | 4/5 | K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3 | 30 min |

| OUTLINE | EQF level (4/5) | LOs | Estimated effort in hours |
|---|-----------------|---|---------------------------|
| 3.6 Creativity techniques | 4/5 | K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3 | 20 min |
| 3.7 Creative Problem Solving | 4/5 | K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3 | 20 min |
| 3.8 SCAMPER | 4/5 | K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3 | 25 min |
| Module 4: Communication and Cooperation | 4/5 | EQF LEVEL 4/5 | 3 |
| 4.1 Definition of the term | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.2 Methods of communication | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.3 Why are communication skills so important today? | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.4 Effective communication | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.5 Main set of principles to achieve effectiveness in communication | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.6 Cooperation-Team Working | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.7 Definition of Cooperation | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| 4.8 Which are the benefits of an effective collaboration, especially after the stress caused by the COVID-19 pandemic | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |

| OUTLINE | EQF level (4/5) | LOs | Estimated effort in hours |
|---|-----------------|---|---------------------------|
| 4.9 Strategies to create a well-balanced and efficient team | 4/5 | K.A4,K.B4,S.A4,S.B4 | 20 min |
| Module 5: Leadership | 4/5 | EQF LEVEL 4/5 | 3 |
| 5.1 Definition of leadership | 4/5 | K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5 | 35 min |
| 5.2 The complexity of leadership | 4/5 | K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5 | 35 min |
| 5.3 Taking charge of initiatives | 4/5 | K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5 | 35 min |
| 5.4 The characteristics of a successful leader | 4/5 | K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5 | 35 min |
| 5.5 Effective ways to lead your team | 4/5 | K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5 | 40 min |
| Module 6: Globalization | 4/5 | EQF LEVEL 4/5 | 3 |
| 6.1 Intercultural understanding | 4/5 | K.A6,K.B6,S.A6,S.B6 | 30 min |
| 6.2 Basic forms and elements of intercultural communication | 4/5 | K.A6,K.B6,S.A6,S.B6 | 30 min |
| 6.3 Different cultures and ways of thinking | 4/5 | K.A6,K.B6,S.A6,S.B6 | 30 min |
| 6.4 Obstacles to an effective intercultural communication | 4/5 | K.A6,K.B6,S.A6,S.B6 | 30 min |
| 6.5 How to improve your intercultural skills | 4/5 | K.A6,K.B6,S.A6,S.B6 | 30 min |
| 6.6 Value of acceptance | 4/5 | K.A6,K.B6,S.A6,S.B6 | 30 min |
| Module 7: Information and data analysis | 4/5 | EQF LEVEL 4/5 | 3 |
| 7.1 Information analysis | 4/5 | K.A7,K.B7,S.A7,S.B7 | 30 min |

| OUTLINE | EQF level (4/5) | LOs | Estimated effort in hours |
|--|-----------------|--|---------------------------|
| 7.2 Types of Information analysis | 4/5 | K.A7,K.B7,S.A7,S.B7 | 30 min |
| 7.3 Data analysis | 4/5 | K.A7,K.B7,S.A7,S.B7 | 30 min |
| 7.4 Information vs Data | 4/5 | K.A7,K.B7,S.A7,S.B7 | 30 min |
| 7.5 Types of data analysis | 4/5 | K.A7,K.B7,S.A7,S.B7 | 30 min |
| 7.6 Control reliability of information | 4/5 | K.A7,K.B7,S.A7,S.B7 | 30 min |
| Module 8: Project Management | 4/5 | EQF LEVEL 4/5 | 4 |
| 8.1 Project and Project Management definitions | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |
| 8.2 Project Lifecycle | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |
| 8.3 Project Planning and Implementation | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |
| 8.4 Risk analysis | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |
| 8.5 Planning tools | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |
| 8.6 The importance of communication | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |
| 8.7 Change of management | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |

| OUTLINE | EQF level (4/5) | LOs | Estimated effort in hours |
|--|-----------------|--|---------------------------|
| 8.8 Necessary steps for a successful change management process | 4/5 | K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8 | 30 min |

4 References

- [1] CEDEFOP, [Defining, writing and applying learning outcomes](#).
- [2] EC, [Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning](#).
- [3] ESCO, [Knowledge definition](#).
- [4] ESCO, [Skill definition](#).
- [5] ESCO, [Competence definition](#).
- [6] ESCO, [Qualification definition](#).
- [7] ESCO, [ESCO qualification pillar](#).
- [8] ESCO, [ESCO Skills pillar](#).
- [9] ECVET, [Identify Units of Learning Outcomes](#).



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