ANNEX 1 SYLLABUS OF THE BASIC VERSION OF THE MILAN TRAINING SYSTEM

Block 1 Basics of Advanced Manufacturing

Module 1.1: Introduction to Advanced Manufacturing

SYLLABUS

This module introduces a student into the world of Advanced Manufacturing. It covers the basics of the topic. The following lessons contain an overview of involved technologies and comparison of their capabilities.

For the adequate acquisition of the learning material, basic knowledge from the material engineering and production engineering is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as electrical engineering and mechanics is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the basic principles of Advanced Manufacturing.
- Describe the main types of technologies involved in advanced manufacturing.
- Show advantages and disadvantages of applying particular technologies of advanced manufacturing for the given cases.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

The module in the pilot version includes 1 lesson. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 1.1.1: What is Advanced Manufacturing

This lesson presents different definitions of the “Advanced Manufacturing”, describes various ways of implementation and present used classifications.

Learning Objectives

- To acquaint the trainees with the main idea of advanced manufacturing;
- Understand how may this idea be implemented;
- To make different classifications of manufacturing processes;

Content of the Lesson

- What is advanced manufacturing - basic concepts and definitions.
- Advanced Manufacturing vs Traditional Manufacturing
- Overview of Technologies used in the modern manufacturing process
- Advanced Manufacturing in the different areas of industry
- Example of working solutions

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 1 Basics of Advanced Manufacturing

Module 1.2: Design of advanced manufacturing systems

SYLLABUS

This module contains presentation of advanced manufacturing techniques and corresponding machinery. It gives an idea how to connect these together to obtain a desired production effect.

For the adequate acquisition of the learning material, basic knowledge from the material engineering and production engineering is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as electrical engineering and mechanics is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Describe the basic advanced manufacturing machines.
- Choose an adequate technology for the given production case.
- Present capabilities of advanced production machines.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

This module in the basic version of the MILAN training system implemented within the project will not contain any lessons.

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 1 Basics of Advanced Manufacturing

Module 1.3: 3D printing in advanced manufacturing

SYLLABUS

This module contains presentation of additive manufacturing. It describes various types of techniques and machines applicable for each of them.

For the adequate acquisition of the learning material, basic knowledge from the material engineering and production engineering is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as electrical engineering and mechanics is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the difference between additive manufacturing and machining.
- Present main technologies of 3D printing.
- Chose a proper technology for the given case (part and material).

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

The module in the pilot version includes 1 lesson. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lesson:

Lesson 1.3.1: Basics of 3D printing

This lesson presents the main concept of 3D printing with a general overview of the most common technologies and materials applicable for this technology.

Learning Objectives

- To acquaint the trainees with the main concept of 3D printing;
- Learn the basics about the printing technologies;
- Teach the student to evaluate a product in terms of choosing the right 3D printing solution
- Understand which materials may be used for them.

Content of the Lesson

- Additive manufacturing - basic concepts and definitions
- Additive manufacturing vs conventional manufacturing
- 3-D printing technologies
    - Material extrusion
    - Vat photopolymerization
    - Power bed fusion
    - Material jetting
- Materials used in the 3-D printing technologies

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 1 Basics of Advanced Manufacturing

Module 1.4: Modern machine tools

SYLLABUS

This module includes a basic idea of a modern machining and an overview of adequate tools.

For the adequate acquisition of the learning material, basic knowledge from the material engineering and production engineering is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as electrical engineering and mechanics is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the basic principles of modern machining.
- Be able to match a case (given geometry and material) with a proper machining tool.
- Compare advantages and disadvantages of the different solutions.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

This module in the basic version of the MILAN training system implemented within the project will not contain any lessons.

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 2 Automation and Robotics in Advanced Manufacturing

Module 2.1: Introduction to Robotics

SYLLABUS

This module includes a basic knowledge in a field of robotics.

For the adequate acquisition of the learning material, basic mathematics, physics and engineering knowledge, including mechanical/electrical engineering, ICT and production engineering, is required. For understanding of the exemplary tasks - elementary knowledge in some technical sciences such as control engineering and general knowledge of manufacturing technologies is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand basic principles of robots' functioning.
- Describe basic types of robots.
- Chose a robot for the given application.

Contributors

Technical University of Kosice TUKE
ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

The module in the pilot version includes 2 lessons. The lessons are accompanied by corresponding presentations, resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 2.1.1: Introduction to Robotics

The introductory lesson focuses on an overview of the development of robotics from the first mechanical solutions, which were not called the word robot, but fulfilled the ideas, principles or functions of robots as we know them today.This lesson presents the selected important

milestones in the development of robotics as well as anticipated development trends in the future.

Learning Objectives

- The general purpose of this lesson is to provide students with an overview of the breakthroughs in the development of industrial robotics in the world and to try to show the anticipated changes that will take place in the coming time.
- Providing students with an image of the development of the first mechanical devices with automatic movements, explaining the meaning and origin of terms commonly used today, e.g. the word robot.
- Description of the birth and use of an industrial robot for the first time and the further evolution of industrial robots to the present day.
- Familiarizing students with important figures in the development of robotics.
- Presentation of the anticipated trends and directions for the further development of robotics.

Content of the Lesson

- Development of robotics until the mid-twentieth century.
- History of industrial robotics.
- Humanoid robots.
- Development trends in robotics.

Lesson 2.1.2: General Terms and Definitions of Robotics

The lesson provides participants with a basic knowledge of what an industrial robot is and what its features are. The participant will know what is the structure of the robot, what the individual terms mean in robotics and what is their meaning in different applications.

Learning Objectives

- To provide basic knowledge of: what is robotics and what benefits it brings to industrial practice.
- To understand the similarity of an industrial robot with human hands.
- To familiarize the pupil with main terms of industrial robots according to the ISO standard.
- The student's acquisition of the ability to name the basic parts of robots.
- To understand by the student the basic elements of industrial robot’s set and its role in specific applications.

Content of the Lesson

- What Is a Robotics and Benefits Of Industrial Robotic Automation
- Similarity of the Structure of the Human and Robot Arm
- Definition of an Industrial Robot
- Structure and Components of an Industrial Robot

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 2 Automation and Robotics in Advanced Manufacturing

Module 2.2: Industrial robotics in advanced manufacturing

SYLLABUS

This module includes a basic knowledge in a field of robotics applied for Advanced Manufacturing.

For the adequate acquisition of the learning material, basic knowledge from the material engineering and production engineering is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as electrical engineering and mechanics is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the possibilities of robot applications in advanced manufacturing.
- Define the basic types of robots applicable for certain processes.
- Describe the main types of manufacturing processes possible for automation.

Contributors

Technical University of Kosice TUKE
Tallinna Tehnikaulikool TTU

Module Structure

The module in the pilot version includes 7 lessons. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 2.2.1: Functions and Parameters of Industrial Robots

The lesson provides an overview of the basic functions of industrial robots, their meaning and mode of operation. Also main parameters, which describe the robots and their work will be discussed. Based on these information which you will be able to choose the right robot for specific applications.

Learning Objectives

- To acquaint the trainees with the main parameters of industrial robots;
- To understand a meaning of parameters and functions of robots (in general);

Content of the Lesson

- Introduction to industrial robotics
- Functions and parameters of robots - definitions

Lesson 2.2.2: Types of industrial robots

This lesson presents different types of industrial robots with their functions and parameters. It will be discussed what types of industrial robots are available on the market, how they work, and what applications or industries they are typically used in.

Learning Objectives

- To distinguish between different industrial robots based on their functions;
- Be able to choose a robot for the particular case.

Content of the Lesson

- Structure of the industrial robot manipulator
- Presentation of main types of robots
    - Functionality
    - Parameters
    - Possible application
- The most popular models used for industry

Lesson 2.2.3: Construction of industrial robot manipulators

This lesson presents a construction of industrial robots regarding their mechanics and drive systems. The basic classification of the motors used in industrial robot (IR) drives was shown. The basic requirements for robotic drives have been discussed

Learning Objectives

The main aim of the lesson is to present the construction and drive systems of industrial robots. The specific objectives are:

- Familiarizing students with the various robot drives solutions used
- Introducing the basic requirements for robotic drives
- Discussion of the drive transmission system, including gears used in robot arms

After studying the lesson, the student will gain knowledge about what types of drives are used by industrial robots, what their advantages and disadvantages are. He will also learn about the mechanisms whose task is to transform the motion of drives (most often the rotation of high-speed electric motors) into the required motion of the robot's arms.

Content of the Lesson

- Robot Driving Systems
- Basic Requirements Concerning Robot Drives
- Drive transfer system in the robot manipulator

Lesson 2.2.4: Industrial robot operation

This lesson presents mentions the purpose of industrial robot operation. A programming unit called Teach Pendant is explained, with which you can move the robot and control of their functions. The idea of the robot coordinate systems is introduced. Different coordinate systems used in robots are described.

Learning Objectives

General aim of this lesson is to acquaint the trainees with the purpose of manual operation of industrial robot. The specific goals are as follows:

- Presentation to pupil the Teach Pendant - one of the most popular devices for robot manual operation
- Introduction and explanation the idea of use the coordinate systems in robot control
- To familiarize pupils with the procedure of robot calibration.

Content of the Lesson

- Robot Control Using Flex Pendant
- Coordinate Systems of Robots
- Robot Calibration

Lesson 2.2.5: Industrial Robot Programming

This lesson presents general rules and practical towards programming of industrial robots. Different methods of robot programming are described. Architecture and structure of a typical robot program has been discussed as well as robot programming languages and tools aided the process of preparation the robot to the application.

Learning Objectives

- To understand rules and methods of robot programming;
- To familiarize pupils with general structure of the robot program
- To provide students with general principles of constructing a program
- To familiarize students with the systems of computer aid simulation and programming of robots

Content of the Lesson

- Early robot programming
- Main robot programming principles
- Architecture and structure of a typical robot program
- Programming languages
- Robot Simulation and Programming Tools

Lesson 2.2.6: End Effectors of Industrial Robots

This lesson presents diversity of end effectors for industrial robots.

Learning Objectives

- To acquaint the trainees with the capabilities of various end effectors.
- Learning to distinguish between different types of end effectors.
- Presentation on how to choose the end effector corresponding to a given case / task.

Content of the Lesson

- Definition End-Effector And Manipulation Process
- Types of end effectors
    - Grippers
        - Mechanic
        - Pneumatic
    - Welding torches
    - Machining tools

  - Sensors
  - Tool changers
- Capabilities of end effectors
- Choice of an end effector

Lesson 2.2.7: Collaborative Robots

This lesson presents an idea and functionality of collaborative robots (cobots). The definition of cobots and their parameters are presented. Specific aspects of cobots applications in different fields of industry have been discussed.

Learning Objectives

- To acquaint the trainees with the definition of cobots;
- To mention parameters and capabilities of cobots.
- To present different aspects of cobots applications;

Content of the Lesson

- Background and definitions of cobot
- Human - Robot collaboration
- Functionality of collaborative robots
- Application of cobots in different fields of industry
- Development trends

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 2 Automation and Robotics in Advanced Manufacturing

Module 2.3: Service robotics in advanced manufacturing

SYLLABUS

This module includes a basic knowledge regarding service robotics applied for advanced manufacturing.

For the adequate acquisition of the learning material, basic knowledge from the mechanical engineering, electrical engineering and production engineering is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as automatic control and ICT is required.

Learning Objectives

Service robots are increasingly used in modern production systems. To be competitive, these systems need not only to be cost-effective, which is largely determined by their productivity. Modern production systems must also be safe for the worker and the environment, flexible, with the ability to quickly respond to changing market needs. This forces the production systems to meet specific requirements in the production itself, as well as in its environment and logistics. Upon completion of this module the students will be able to:

- study and understand issues related to the use of service robots in manufacturing plants,
- understand the problems arising from the specific logistic requirements in modern industry
- notice the possibilities and assess the benefits of using service robots in a specific production process in advanced manufacturing,
- propose a comprehensive solution for retrofitting the existing or designing a new production installation, with use of service robots.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

The module in the pilot version includes 2 lessons. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 2.3.1: Basic terms and definitions for service robotics

This lesson provides a glossary of basic concepts, definitions and terms for service robots in their various applications. All terms are sorted alphabetically.

Learning Objectives

- To acquaint the trainees with the terms, definitions and vocabulary related to service robots
- enabling students to lead further independently study and understand issues related to the use of service robots in various areas of life

Content of the Lesson

- Different definitions connected with service robots

Lesson 2.3.2: Tasks in manufacturing plant carried out by service robots

This lesson presents approach towards carrying out some tasks in factories by service robots. The content of the lesson is focused on AGV - Automated Guided Vehicles.

Learning Objectives

- To acquaint the trainees with the possibilities of application different types of service robots for manufacturing plants.
- For the student to understand the problems arising from the specific logistic requirements in modern industry.
- To familiarize students with the potential of service robots
- Presentation to student how to use service robots in practice to increase the efficiency of the manufacturing process.

Content of the Lesson

- Introduction to AGV - Automated Guided Vehicles
- AGV vehicles
    - AGVs as part of FMS

    - Types of AGVs
    - Examples of AGVs
- Mobile robotics tasks performed by AGVs
- AGV control methods
- Power supply of AGVs
- AGV running system
- Safety of AGV vehicles

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 2 Automation and Robotics in Advanced Manufacturing

Module 2.4: Best practices – areas of application

SYLLABUS

This module includes basic knowledge regarding application of robotics in manufacturing systems. The content of the module is divided into lessons about different areas of application.

For the adequate acquisition of the learning material, basic knowledge from the advanced manufacturing as well as automation and robotics is required. It is advisable for the student who takes the lessons from this module to read the lessons from modules 1.1, 2.1, 2.2 and 2.3 earlier.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the basic requirements and principles of robotization in various areas of production.
- Indicate the main problems of robotization of the process or manufacturing operation
- Propose a general configuration of a robotic installation for a new process.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

The module in the pilot version includes 2 lessons. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 2.4.1: Robotics in Automotive

This lesson presents different examples of the robotic installation in manufacturing plants from automotive area. Various types of robots and their equipment that is used to perform these tasks will be presented.

Learning Objectives

- To acquaint the trainees with the main problems specific for applications of robots in automotive industry;
- Presentation of sample robotic applications in the automotive industry;
- Indication of sources of information on robotics in the automotive industry.

Content of the Lesson

- Characteristics of automotive industry
- Requirements and principles of robotization specific for automotive industry:
  - various operation – specific tasks for robot in automotive plant,
  - various types of robots,
  - equipment of robots.

Lesson 2.4.2: Robotics in Manufacturing of food and beverages

This lesson presents various examples of robot installations in production plants in the food industry, in particular food and beverage production.

Learning Objectives

- To acquaint the trainees with the main problems specific for applications of robots in food and beverage production industry;
- Presentation of sample robotic applications in the food and beverage industry;
- Indication of sources of information on robotics in the food and beverage industry.

Content of the Lesson

- Requirements and principles of robotization specific for food and beverage industry:
  - various operation,
  - various types of robots,
  - equipment of robots.
- Sample robotic applications in the food and beverage industry.

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 2 Automation and Robotics in Advanced Manufacturing

Module 2.5: Best practice – robotized technologies

SYLLABUS

The module contains knowledge about the robotization of various technologies used in production systems. The content of the module is divided into lessons, each of which relates to one robotic technology.

Taking into account the features of the technology, the reasons for its robotization can be divided into 3 groups:

a) OSH (Occupational Safety and Health) – working conditions in the implementation of technology are difficult / dangerous enough that people do not want to work in them.

b) The requirements of the technology itself – it must be implemented by the machine for various reasons, e.g. the weight of the tool is too great for a person, the required precision of the tool is unattainable for a person

c) Cost-benefit ratio – the use of robots is cheap and simple and brings significant economic benefits.

As a rule, in specific cases we have reasons for two or all of the above mentioned three groups, but you can usually indicate the dominant group.

For the adequate acquisition of the learning material, basic knowledge from the advanced manufacturing as well as automation and robotics is required. It is advisable for the student who takes the lessons from this module to read the lessons from modules 1.1, 2.1, 2.2 and 2.3 earlier.

Learning Objectives

Upon completion of this module, the students will be able to:

- understand the basic requirements and principles of robotization in various areas of production technology,
- identify / indicate the main problems of robotization for various processes,
- propose a general configuration of the robotic installation for the production process in a specific technology.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

The module in the pilot version includes 3 lessons. Each lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 2.5.1: Robotics in Arc welding

This lesson presents general characteristics of welding processes and the specificity of their robotization. Particular attention was paid to working conditions in welding processes. Various configurations of robotic welding stations and examples of specific implementations will be presented.

Learning Objectives

- To acquaint the trainees with the main problems of the robotization of arc welding processes;
- Learning the rules for the selection of a robotic system configuration and robot type for arc welding robotization;
- To familiarize participants with examples of well-implemented applications of the robotic arc welding technology.

Content of the Lesson

- General presentation of the welding technology - classification.
- Requirement and conditions of welding processes
- Configuration of robotic arc welding cells
- Robots for arc welding
- Additional equipment for robotized welding
- Sample robotic applications for arc welding

Lesson 2.5.2: Robotics in Metal cutting and bevelling

This lesson presents the general characteristics of metal sheet cutting and beveling. Methods for implementing these processes in industrial conditions will be discussed. Typical hazards occurring at work stations during cutting and beveling will be indicated. Various cutting technologies will be presented: oxygen, plasma, laser, mechanical and types of robots used to robotize these operations. Various configurations of robotic cutting / beveling stations and examples of specific implementations will be presented.

Learning Objectives

- To acquaint the trainees with the main problems of the robotization of cutting/beveling processes;
- Learning the rules for the selection of a cutting technology, robotic system configuration and robot type for robotization of cutting/beveling operations;
- To familiarize participants with examples of well-implemented applications of the robotic cutting/beveling technology.

Content of the Lesson

- General presentation of the cutting/beveling technology.
- OSH on the cutting/beveling workplaces
- Requirement and conditions of cutting/beveling processes
- Cutting technologies
- Configuration of robotic cutting/beveling cells
- Robots for cutting/beveling of metal sheets
- Technical problems by robotic cutting/beveling
- Sample robotic applications for cutting/beveling

Lesson 2.5.3: Robotics in Material handling

This lesson introduces the general characteristics of using robots to automate the task of material handling. Various types of these processes carried out in industrial conditions will be discussed, incl. machine operation (loading / unloading, palletization, inter-operational transport). Various types of robots used to automate these operations will be presented. Examples of specific applications will be presented.

Learning Objectives

- To acquaint the trainees with the main problems of robotization of material handling processes;

- Presentation of the principles of selecting the configuration of a robotic system, the type of robot and its accessories for the robotization of material handling operations;
- To acquaint students with examples of successful implementations of robotic material handling technology.

Content of the Lesson

- General presentation of the material handling operations in real industry environment.
- Grippers and a Gripping Devices in material handling applications
- Typical tasks related to material handling by a robot

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 3. ICT in Advanced Manufacturing

Module 3.1: Automated and IT-based manufacturing

SYLLABUS

This module includes basic topics of Industry 4.0 theory and practice. The information material can be used by all persons interested in innovation trends in manufacturing and digital revolution starting from high school learners through university students, to working engineers and production management.

For the adequate acquisition of the learning material, only basic general technical knowledge is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the basic concept of Industry 4.0.
- Describe major components of Industry 4.0 and their role in manufacturing in digital area.
- Describe examples of smart factory, cloud computing, Industrial Internet of Things.

Contributors

Bialystok University of Technology BUT

Module Structure

The module in the pilot version includes 3 lessons. Each lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject.

The module consists of the following lessons:

Lesson 3.1.1: An introduction to Industry 4.0 – new concept in advanced manufacturing

This lesson defines basic concepts related to Industry 4.0, describes how the production environment has changed and indicates main benefits and challenges associated with the use of modern technologies in industry.

Learning Objectives

- to understand core idea of Industry 4.0
- to understand roots of industrial revolution
- to specify basic principles of Industry 4.0
- the ability to find benefits and challenges of Industry 4.0

Content of the Lesson

- What Industry 4.0 is?
- The evolution of industrial revolution (from 1st to 4th)
- Principles of Industry 4.0
- The challenges and impact of Industry 4.0

Lesson 3.1.2: Four major components, defining the term "Industry 4.0" or "smart factory"

This lesson shows and explains major components of the Industry 4.0 concept.

Learning Objectives

- to understand what is Industrial Internet of Things (IIoT)
- to understand what is cloud computing
- to understand what is cyber-physical system
- to understand what is cognitive computing

Content of the Lesson

- Explanation and demonstrations how Industrial Internet of Things (IIoT) works and what are their main components.
- Explanation what are main components of computation cloud and demonstration of their basic usage
- Explanation what a cyber-physical system is and examples of solutions
- Explanation what cognitive computing is and examples of solutions

Lesson 3.1.3: Digital solutions and advanced technologies associated with Industry 4.0

In this there are described concepts of three main subjects of digital solutions and advanced technologies used in Industry 4.0: Big Data and Analytics, cloud computing and Industrial Internet of Things. The importance of deployment and usage of big data analysis tools are explained.

Learning Objectives

- to understand the role of Big Data and Analytics in Industry 4.0
- to understand the role of cloud computing in Industry 4.0
- to understand the role of Industrial Internet of Things
- to understand why the collection of data are strongly connected with the usage of Internet of Things
- to observe and understand examples of digital solutions

Content of the Lesson

- Demonstrations how Industrial Internet of Things (IIoT) can significantly improve operations, increase efficiency and reduce costs.
- What is the big data's role in the fourth industrial revolution.
- Why cloud computing
- Information of data's collection from IIoT, the role of data analysis.
- Examples of digital solutions.

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 3. ICT in Advanced Manufacturing

Module 3.2: New ICT in advanced manufacturing

SYLLABUS

This module includes basic topics refer the new ICT concepts and tools, which are used in the control and management of advanced manufacturing systems. The information material can be used by all persons interested in innovation trends in manufacturing and digital revolution starting from high school learners through university students, to working engineers and production management.

For the adequate acquisition of the learning material, basic knowledge from the ICT is required, and for understanding some of the exemplary tasks - elementary knowledge in some technical sciences such as electrical engineering and automatic control is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the role of ICT in advanced manufacturing systems.
- Capable of assessing the possibility of collecting, archiving and processing data from an advanced production system.
- Capable of proposing information / data transfer between the manufacturing process and other control layers, including remote ones, via the Internet.
- Understand the possibilities that new ICT concepts create to increase the efficiency of created systems, e.g. AR, VR, Internet of Things.

Contributors

Polytechneio Kritis / Technical University of Crete (TUC)

Module Structure

The module in the pilot version includes 1 lesson. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

The module consists of the following lessons:

Lesson 3.2.1: Application of VR and AR in manufacturing

This lesson presents Virtual Reality (VR) and Augmented Reality (AR) as new ICT solutions which can be useful, effective and profitable in the installations of Advanced Manufacturing.

It also presents applications of AR and VR technologies in Industry and Manufacturing, and in particular in Education and Training, Design and Development, Servicing and Maintenance, and Task support and collaboration.

Learning Objectives

- To show the properties, characteristics and differences of VR and AR.
- Presentation of devices implementing VR and AR.
- To familiarize students with specific examples of the use of VR and AR in production processes.

Content of the Lesson

- AR vs VR.
- AR and VR Hardware
- Applications of AR and VR in Industry and Manufacturing

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 3. ICT in Advanced Manufacturing

Module 3.3: Communication in advanced manufacturing systems

SYLLABUS

This module includes basic topics refer the data exchange concepts and tools, which are used in the control and management of advanced manufacturing systems. The industrial communication networks, which guarantees high capacity and availability of automation networks, will be explained. The lesson will cover the full range of networks used in the production system from the floor level (single machines and stations) to the management level. Popular practical implementation of industrial networks solutions, will be presented.

For the adequate acquisition of the learning material, basic knowledge from the ICT and familiarity with modern electronic communication tools is required.

Learning Objectives

Upon completion of this module the students will be able to:

- Understand the basic principles of data exchange in the industrial environment.
- Describe general structure and major components of Industrial communication network.
- Describe examples of practical solution for different levels, available on the market.
- Effectively seek standardization regulations to solve a specific problem of communication in industrial environments.

Contributors

ŁUKASIEWICZ Research Network – Industrial Research Institute for Automation and Measurements PIAP

Module Structure

This module in the basic version of the MILAN training system implemented within the project will not contain any lessons.

The lessons can be realized within the future implementation of the MILAN Training System, after project termination.

Block 4 Occupational safety and health

Module 4.1: Safety and safety systems in advanced manufacturing

SYLLABUS

This module provides basic information on occupational health and safety issues and safety systems in advanced manufacturing installations, especially with important use of robotic. The inevitable consequence of the development of existing and the introduction of new technologies is the emergence of new threats at workplaces. The related problems and methods of solving them are the subject of legal and standardization regulations, which are presented in the lessons of the Module. The following sections discuss the sources of hazards and risk assessment procedures in robotic installations. Technical methods of improving the safety of employees operating and servicing this type of production installations were also presented.

Basic knowledge of production and materials engineering is required to adequately assimilate the teaching material in this module, and to understand some of the sample tasks, basic knowledge of some other technical sciences such as electrical and mechanics, automation, communication and information techniques is also required. It is also advisable to familiarize yourself with the additional materials, in particular with Annex A1 entitled "Standards in area of robotics"

Learning Objectives

Upon completion of this module, students will acquire knowledge and skills in the following areas:

- Basic health and safety problems in advanced production installations, especially with the significant use of robotic technologies.
- Basic legal and standardization acts regulating health and safety issues in robotized installations.
- Hazards and risk assessment in robotized manufacturing installations.
- Technical and organizational methods influencing the improvement of employee safety in robotized production installations.

Contributors

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Module Structure

The module in the pilot version includes 4 lessons. The lessons are accompanied by a corresponding presentations, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

Next lessons can be realized within the future implementation of the MILAN Training System, after project termination.

The module consists of the following lessons:

Lesson 4.1.1: Occupational Safety and Health in the Robotized Installations in general

Consumer safety related to the use of products and the safety of workplaces are treated with the greatest attention in the European Union. Relevant objectives related to ensuring this safety found an important place in EU legal acts, such as Regulations and Directives, as well as in the system of standards. Industrial robots, automated and robotized manufacturing cells and lines are important subject to these relevant regulations and directives on machinery, including related to OHS. This lesson introduces students to these topics and provides an overview of the basic health and safety issues in manufacturing installations. It is focused on health and safety issues of machines, in particular industrial robots, as well as robotic cells and lines. The presented knowledge is needed both by the designer, contractor, importer of industrial robots and production lines, as well as the employer who will use these robots and production lines and where these devices are workplaces

Learning Objectives

The aim of the lesson is to provide participants (students and pupils) with the content of the lesson in a clear and concise manner. It is assumed that after mastering the lesson material:

- The participant will understand the meaning and importance of activities undertaken in a production company for Occupational Safety and Health (OSH).
- Student will understand the goals and tasks of preventive actions of OHS services and understand the obligations of the employer and employee in organizing a safe workplace.
- Student will be able to identify threats at the workplace and set appropriate levels of risk for these threats.

Understanding by the pupil, and worker in the future, the sense and purposefulness of actions taken in the field of occupational health and safety by individual employees should translate into better, more effective and safer work organization of the entire enterprise.

Content of the Lesson

- General issues of OHS in advanced manufacturing.

- The Machine as a Product and the Machine as an Element of Workplace Equipment.
- Risk Assessment of Robotic Workplaces.
- Robotic Installation Documentation.
- Modernization Works.

Lesson 4.1.2: Law and standards in OSH in area of Robotics

This MILAN lesson focuses on European legal and standards issues related to the safety of work in robotic production installations. The problems of machinery safety from the point of view of the manufacturer of a safe product were presented. This approach is in line with the spirit of EU law. We think about product safety already at the stage of its design. In this lesson, the student is introduced to the legal and technical issues related to the process of assessing product compliance with the essential requirements of the New Approach Directives.

The acquired knowledge will be useful to the student in the future when he is involved in the process of buying / selling the machine, the seller-client, and when he is involved in the process of designing and manufacturing a new product, or in the process of creating a safe workplace.

Learning Objectives

The general aim of this lesson is to familiarize students with European Union product safety law and standards. The specific learning objectives are as follows:

- Presentation of EU legal regulations for machines, including industrial robots and robotic production stations.
- Familiarize the pupil with New Approaches Directives.
- Familiarize the pupil with European system of standards, including harmonized standards.
- Presentation of the rules of European Single Market protection.
- Presentation of general procedure of the conformity assessment.

Content of the Lesson

- EU Legal Regulations Regarding Safety of Products
- New Approach Directives
- Harmonized standards
- Protection of the European Single Market
- Product conformity assessment

Lesson 4.1.3: Safety of industrial robotics - source of hazards, risk, standards requirements

This lesson focuses on hazards, risk assessments, standards related to the industrial robots and robotized installations. Also, the minimal requirements of the WED Directive are explain.

Learning Objectives

The overall purpose of the lesson is to familiarize students with the requirements of the Directives and standards that apply to machines, including robotic workstations and machines that are workstations. The specific goals of education are as follows:

- Presentation of selected standards related to the safety of robots and robotic systems, including C-type standards
- To familiarize the student with the requirements of the WED Tool Directive;
- Provide the student with the principles of searching for documents related to the safety of robots and robotic installations.

After learning the lesson material, the student will better understand EU product regulations, including the manufacturer's responsibility for the product and the employer responsibility organizing a safe workplace.

Content of the Lesson

- Requirements of harmonized standards.
- Requirements of the WED Directive
- Important EU legal acts and harmonized standards relating to machines

Lesson 4.1.4: Securing of the robot's work area - protective devices and systems

This lesson provides a general overview of the methods and protective measures used to separate the work area of an industrial robot from the operator's work area in robotic manufacturing installations. The essential requirements for shields and protective measures according to Appendix IV of the Machinery Directive have been discussed.

Learning Objectives

Mastering the lesson material will allow the student to better understand the essential requirements of the Directive and the requirements of the harmonized standards regarding protective measures used to ensure the safety of the operator of a robotic production station. The specific goals of education are as follows:

- Familiarize the pupil with legal and normative requirements for protective methods and devices in robotized installations

- Familiarize pupil with elements used for realization of protective system in robotized installation
- Familiarize pupil with devices used for realization of protective system in robotized installation

The acquired knowledge will enable the student to make conscious choices of guards and protective measures adequate to the tasks related to ensuring safety at the robotic production station.

Content of the Lesson

- Legal and normative requirements for guards and protective devices
- Methods and protective measures used in robotic manufacturing workstations
- Protective elements
- Protective devices
- Other safety measures

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.

Block 4 Occupational safety and health

Module 4.2: CE certificate for advanced manufacturing systems

SYLLABUS

This module includes basic knowledge about rules of conduct when introducing equipment and entire advanced manufacturing systems to the market, in accordance with the law and standards that are in force in the European Union.

Learning Objectives

Upon completion of this module students will acquire knowledge and skills in the following areas:

- Basic rules of conduct when introducing products to the EU market.
- Responsibilities of the operator of the robotic installation and its user.
- Conformity assessment of the robotic installation.
- Rules for labeling robots and robotic installations.

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Module Structure

The module in the pilot version includes 1 lesson. The lesson is accompanied by a corresponding presentation, a number of resources for further study and self-assessment consisting of multiple choice questions to assess your knowledge on the subject and some exercises/assignments to apply the knowledge you gained in practice.

Next lessons can be realized within the future implementation of the MILAN Training System, after project termination.

The module consists of the following lessons:

Lesson 4.2.1: Certification of robotized manufacturing installations

This lesson focuses on machine certification issues, specifically the certification of robotic production lines, workstations and cells. Issues, problems and differences related to voluntary and compulsory certification have been explained. The benefits of certifications and third party independent assessments have been provided. It describes the certification of complex machines that include robotic production lines, both those that were produced in the EU and machines from non-EU countries.

Learning Objectives

The aim of the lesson is to familiarize pupils and students with the practical problems related to the certification of robotic production lines. The specific educational objectives of this lesson are as follows:

- Explaining to students what is certification, what benefits both producers and recipients,
- To familiarize students with the assessment of product conformity in relation to robots and robotic installations.
- Explain to students the importance of labeling.
- Communicate information about certificates of unknown origin to students with caution.

Content of the Lesson

- EC / EU Certificates and Declarations of Conformity.
- Conformity assessment and certification of a robotic installation.
- Reliability of certificates.

Subsequent lessons can be realized as part of the future implementation of the MILAN training system, after the end of the project.