Professional Qualification: MANAGEMENT AND SUPERVISION OF 3D PRINTING SYSTEMS, IN PROFESSIONAL ENVIRONMENTS.

Associated Vocational Families: (Electricity-Electronics, Computing, Mechanical Manufacturing)
Level3
Code ESDEI3D_3
Draft 1
Situation Final

General competence
Perform the processes of Management and Supervision of 3D printing systems by applying the technologies and knowledge of specific materials in the 3D printing process, with quality, safety and respect for the environment criteria.

Units of competence
UC0006_3: Manage and supervise the assembly and maintenance of 3D printers, in industrial, personal and social environments.
UC0007_3: Use 3D printers, to obtain final products.
UC0008_3: Technologies and knowledge of materials for 3D printing.

Professional field

Professional context
Its activity is organised in functions or supervision of assemblies, maintenance and use of 3D printing equipment, and technical advice on the specific materials used in the 3D printing process.

Productive Sectors
This qualification is located in the subsector of industries and companies dedicated to 3D printing, as well as in the technical advice of the materials used in 3D printing, framed in the industrial, architectural, civil engineering, clinical, agri-food, artistic, educational, sports, domestic and other scientific-technological sectors.
Construction of machinery, mechanical equipment and industrial products in the different production sectors.

Main jobs and employments
3D printers technician.
3D printing technician.
Technician in specific materials for 3D printing.

Associated training (... h)

Formative modules
MF0006_3: Assembly and maintenance of 3D printing systems (... h)
MF0007_3: 3D printing (... h)
MF0008_3: 3D materials (... h)

UNIT OF COMPETENCE 6: Manage and supervise the assembly and maintenance of 3D Printers, in industrial, personal and social environments.

Level 3
Code UC0006_3

Professional achievement and implementation criteria

RP1: Arrange the working area, prepare equipment, tools, instruments and EPIs, to join the elements and structures of 3D printers, complying with the rules of prevention of occupational and environmental risks.

CR1.1 In the conditioning of the work area, the dimension of the 3D printer, the necessary auxiliary spaces, weights to be supported and the maneuvers to be performed have been taken into account.
CR1.2 The materials, machines, equipment, tools, work tools and accessories necessary for the development of the specified work are selected in compliance with the instructions and standards for prevention of occupational risks.
CR1.3 Machines or equipment are kept operational by applying user maintenance procedures.
CR1.4 The security of the equipment and personal means are prepared according to the requirements of the required safety standards.

RP2: Join elements and components of 3D printers according to the specifications, complying with the rules of prevention of occupational and environmental risks.

CR2.1 The assembly and positioning of the elements or constructions is done following the sequence of operations indicated in the technical documentation and within the admissible tolerances for later joining.
CR2.2 The assembly is carried out according to the specifications of the construction drawings and the connection points are made in the appropriate place and with the established procedure.
CR2.3 The handling of the means and auxiliary tools of assembly, is done without interference and complying with the rules of prevention of occupational risks.
CR2.4 The union of elements and materials is done by taking the necessary measures and complying with the specifications.
CR2.5 The use of safety equipment and means is done according to the requirements of the safety regulations.

RP3: Carry out the start-up and functional tests of the equipment and all its elements of the 3D printing systems, according to the technical documentation, instructions given and manufacturer's standards, applying the established procedures, in conditions of quality and safety, and complying with current regulations.

CR3.1 The assembly, anchoring and leveling of the machinery has been carried out following established procedures, using the tools and tools specified in each case, ensuring the absence of damage and the functionality of the equipment.
CR3.2 The connections to the networks of energy fluids and services are made with the kind and type of elements described, accessories, devices, materials required by the technical specifications, and are made:

- Complying with the applicable regulations.
- Using the type of electrical channeling, routing and fastening specified in the assembly documentation, avoiding mechanical stresses and complying with the technical specifications.
- With the conductors of section, insulation, stiffness and protection specified, without changing their characteristics during assembly.
- Using the required terminals and connectors, connected to the necessary pressure and identifying the conductors in accordance with the diagram.
- Supervising the food protections, complying at all times with the requirements of the applicable regulation regarding low voltage.
- The power values are correct for the electrical, hydraulic or pneumatic elements.

CR3.3 The start-up is made:

- Following the sequence of commissioning according to what is indicated in the project.
- Loading control programs and operating the 3D printing machine following the established procedures, with the guards and quality systems activated.
- Visualizing the information provided by the screens, if any, which is appropriate and corresponds to the actual state of the machine or equipment.
- The correct functioning of mobile systems and the absence of elements that interfere with it.
- Regulating the operating parameters within the established ranges of action, adjusting them if necessary and following the procedures indicated in the corresponding manuals.
- The safety systems of the equipment act correctly, according to the manufacturer's instructions and current regulations of application.

CR3.4 The functional verification of the system is carried out according to the technical documentation.
CR3.5 The work developed and the modifications introduced are included in the assembly report or work order.
CR3.6 Operations are carried out according to quality criteria and in accordance with the plan for the prevention of occupational risks and environmental protection.

RP4: Implement the program of preventive and predictive maintenance of 3D printing equipment, revising the operating conditions of the installation and its components, in the established deadlines and times, in conditions of quality and safety, and complying with current regulations.

CR4.1 The technical manuals of the equipment, installation and accessories are consulted, when necessary, in maintenance interventions.
CR4.2 The technical means, tools and measuring devices are adequate and are used according to the requirements of each intervention, and must be adjusted and with the corresponding calibration certificate in force when required by regulations.
CR4.3 Preventive and predictive maintenance operations are carried out following the maintenance plan.
CR4.4 Maintenance is carried out following established protocols and taking into account, among others:
- External cleaning and absence of deformations in equipment, installation and accessories.
- Connections and continuities of cables, connectors, power strips, among others, both power and communications.
- The functionality of the control equipment of the safety devices of the system, of the electrical, pneumatic and hydraulic elements and of the field elements.
-The adjustment and calibration of equipment and system elements.

CR4.5 The work order of the intervention carried out is completed in the corresponding format indicating the elements replaced, the modifications introduced and the actions carried out, among others, for their incorporation into the history of the installation, as well as the communication to the person in charge of the impediments observed in maintenance.
CR4.6 Operations are carried out according to quality criteria and in accordance with the plan for the prevention of occupational risks and environmental protection.

RP5: Diagnose and repair the dysfunctions or breakdowns found in the field of its competence, applying it to 3D printing systems, based on the symptoms detected, manufacturer information and history of breakdowns of the equipment, meeting the established deadlines, under quality conditions and security, and complying with current regulations.

CR5.1 The initial tests or observations allow to verify the symptoms of dysfunction or breakdown collected and are contrasted with the history of the equipment.
CR5.2 The possible dysfunction is checked according to instructions, performing the usual starting sequence and acting in a routine way to gather information about it.
CR5.3 The initial hypothesis and the plan of action developed allow to diagnose and precisely locate the damaged device as well as the cause that produces it, evaluating the possibilities of repair or its transfer to the person in charge, as well as establishing priorities according to the level of risk of repair and availability of use of the installation.
CR5.4 The diagnosis and location of the malfunction or breakdown is made using the technical documentation of the installation, when necessary, with the appropriate tools and measurement devices, applying the established procedure.
CR5.5 Replacement of the damaged element is carried out using the disassembly and assembly sequence recommended by the manufacturer, ensuring that the element, component or part of the equipment, installation or accessory replaced is identical or compatible with the damaged one and does not alter any mandatory regulation. Fulfillment.
CR5.6 The waste generated is collected according to the waste management plan.
CR5.7 The extensions and updates carried out verify that they do not alter the intended purpose, the conditions of the equipment nor the initial quality conditions set by the manufacturer.
CR5.8 The work developed is included in the repair report.
CR5.9 Operations are carried out according to quality criteria and in accordance with the plan for the prevention of occupational risks and environmental protection.

Professional context

Means of production

Measurement and verification instruments. Tools and supplies for assembly and installation. Fixing systems, manual tools for mechanical work (pliers, screwdrivers, among others). Manual tools for electric-electronic works (crimping pliers and fiber cutters, among others). Lifting and transport means. Review equipment. Machines for pneumatic and hydraulic works. Machines for mechanical works. Equipment for electrical, electronic, pneumatic and hydraulic tests, as measuring instruments (phase tester, network certifier, manometer, multimeter, oscilloscope, wiring tester, among others). IT tools Equipment for the

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prevention of occupational risks. Maintenance management software. Fault history. Team book. Warehouse book.

Products and results

3D printing systems mounted and diagnosed.
Maintenance in 3D printing systems.
3D printing systems start-up.

Used or generated information

Plans and assembly diagrams and work instructions, electrical, pneumatic, hydraulic, situation and connection diagrams. Lists of materials. Assembly sequences. Machine manuals. Installation manual, user maintenance and technical service. Quartering. Project documentation. Work orders. Failures reports. Technical protocols of action. Rules for equipment maintenance, standards for quality control, regulations for prevention of occupational and environmental risks and applicable regulations. Assembly report. Breakdowns historic report. Team book.

UNIT OF COMPETENCE 7: Use 3D printers to obtain final products.

Level 3
Code UC0007_3

Professional achievement and implementation criteria

RP1: Interpret and manage the digital information necessary to print the elements and/or 3D models.

CR1.1 The digital files containing the model to be printed in 3D are received, applying the rules established for the process.
CR1.2 The digital files that contain the model to be printed in 3D are protected by backing up the file according to established procedures.
CR1.3 The digital information is checked by checking that it corresponds with the technical specifications of the work order.
CR1.4 Digital files are opened using specific computer applications.
CR1.5 Corrected digital files are saved using specific computer applications.
CR1.6 The compatibility between computer programs is checked by pre-checking, verifying that the validated digital files are compatible with the control and management software of the printing device.
CR1.7 The operational status of equipment, tools, instruments and materials is maintained by the established plan.
CR1.8 The process, control and maintenance documents used are formalized according to the correct use of the specific terminology and lexicon.
CR1.9 Digital information is sent to 3D printing devices, using the appropriate computer applications.
CR1.10 The work activities in the printing equipment are organized with efficiency criteria from the production order.
CR1.11 The data corresponding to the calibration of the digital file is entered using the required software.
CR1.12 The correction parameters of the digital file are made on specific programs.
CR1.13 The status and performance of 3D printing equipment is pre-tested, according to the manufacturer's manual.

RP2: Prepare the equipment, adjust the parameters and make the printing of the elements and/or 3D models.

CR2.1 The materials to be used in 3D printing are checked by verifying their physicochemical structure and their characteristics in relation to the manufacturing order.
CR2.2 The surface finish and the color of the element to be printed is checked, assessing that they correspond to the specifications of the work.
CR2.3 The quantity and quality of the item to be printed are checked by verifying that it corresponds with that established in the production order.
CR2.4 The material to be used in the printing is transported from the warehouse, following the established protocols and safety standards.
CR2.5 The material to be used in printing is handled and treated according to the established working methods, which ensure its entry and passage through the machine.
CR2.6 The material feeding system is prepared by adjusting it to obtain an impression according to the established quality.
CR2.7 The adjustable elements of the device are prepared by adjusting them according to the needs of the material used and/or the design to be printed.
CR2.8 The contribution of the material in the manufacturing process of the element is controlled visually and / or by the printing management software, according to the established control plan.
CR2.9 The anomalies that arise during the start-up of the printing device, movements in the support, misalignments in the amount of raw material used, and others, are corrected until reaching the required printing parameters.
CR2.10 The first printed element is checked by checking: its dimensional and / or geometric tolerances, colors, physical-chemical properties, defects and others, according to the characteristics specified in the manufacturing order.
CR2.11 The process variables are modified, according to the valuation and the results of the first printed element.
CR2.12 The correction and adjustment is carried out by acting on the elements, parameters and/or control mechanisms, model design and chromatic correction of the machine, if applicable.
CR2.13 Adjustments are made in compliance with the applicable regulations for the prevention of occupational and environmental risks.
CR2.14 Quality control of the process is carried out according to the established work method, both in terms of the characteristics to be controlled and the way to perform it and its periodicity, and a sample of the printed element must be taken periodically applying the procedures of quality established.

CR2.15 The results of the verification are arranged in the control sheets in this regard, indicating the incidents for analysis.
CR2.16 The production parts are filled in to check the agreement between the specified productivity and the one obtained.
CR2.17 The security devices of the 3D printing machine are checked, checking their correct operation, following established procedures.
CR2.18 The maintenance plan of the printing equipment is carried out following the instructions of the manufacturer of the machine and the established procedures.
CR2.19 The elements of the 3D printing equipment comply with the cleaning levels established in the maintenance regulations.

RP3: Management of safety and environmental protection in 3D printing processes

CR3.1 The information and training provided is verified to be adapted to the needs established in the risk assessment and to the planning of the preventive activity.
CR3.2 The resources necessary to achieve the objectives of the prevention plan in the 3D printing section are identified and adapted to the real needs of the working and environmental conditions, participating in the determination and election of the same.
CR3.3 The own operations of the processes of 3D printing are supervised verifying that they respect the norms and procedures of work in matter of security and environmental protection established in the general plan of prevention.
CR3.4 The use of personal protective equipment (safety footwear, hearing protection helmets, protective gloves against mechanical, chemical and / or thermal aggressions, protective goggles, masks with the appropriate filters, safety belts and others), it is checked by checking that they are used according to the current regulations.
CR3.5 The corrective measures proposed for the prevention and elimination of identified risks are evaluated in collaboration with the prevention technician, to assess their feasibility and compatibility with production and the improvement of safety and environmental protection in the 3D printing processes.
CR3.6 The security devices of 3D printing equipment and machines, (apartabodies, fixed or mobile guards, sensitive control, interlocking devices, emergency stops, photocells or other devices), are periodically checked, verifying their correct functioning and adaptation to the applicable regulations, according to the current prevention and safety plan.
CR3.7 The signaling of the risk areas in the 3D printing section is checked by verifying its correct visibility and that the requirements established in the current regulations are met, notifying the prevention service of any anomaly.
CR3.8 Cleaning and maintenance operations in 3D printing processes (feeding systems, step and exit, printed forms, auxiliary elements, replacement operations of interchangeable elements, cleaning and lubrication of all elements), they are supervised verifying that the appropriate products are used and that the established work procedures are complied with.
CR3.9 The incidents or anomalies detected in issues related to environmental protection in 3D printing processes are resolved, in collaboration with the technician responsible for prevention, taking corrective measures that allow their solution immediately.
CR3.10 The proposals for improvement in preventive matters are applied in collaboration with the responsible superior for the improvement of safety and health.

Professional context

Means of production

Computer equipment, capture and digitization equipment. Image processing software. Software for 3D printing. 3D printers and digital process simulation systems. Drivers Servers of repositories and elements of communication. 3D printing machine, work desk with normalized light. Verification elements. Software for the evaluation of occupational risks in 3D printing processes. Personal protection equipment (EPIs). Collective protection equipment. Safety systems for machines and transport equipment. Portable safety detectors. Emergency devices for first aid or emergency response. Fixed and mobile emergency equipment. Fire ladders, extinguishers, hoses, emergency lighting, warning signs. Environmental detectors Security signage or labels for all types of risks. Selective waste containers.

Products and results

Received files, optimized for processing or reproduction of 3D models. Digital information treated. Control and maintenance documentation. Elements printed in 3D. First level maintenance. Occupational risk and environmental protection plan. Evaluation of occupational and environmental risks linked to 3D printing processes. Reports of incidents and accidents analyzed in printing processes. Proposed preventive measures to carry out in the processes. Tokens of each job with associated risks. Product safety sheets.

Action protocols applied in different emergency situations. Environmental management of the 3D printing section. Waste management in the printing process.

Used or generated information

Technical documentation of equipment. File management manuals. User manuals. Work order. Applicable regulations for the prevention of occupational and environmental risks. Manufacturing order Technical documentation of 3D printing equipment, applicable regulations for prevention of occupational and environmental risks. Standards and quality standards. Preventive maintenance plan. Control plan. Plan for the prevention of occupational risks and environmental protection. Self-protection plan. Documentation required in environmental matters. Manuals of the printing process. Plans or schemes of printing machines and equipment. CE mark standards. Manuals and standards of safety, health and environmental protection. Recommendations and instructions for the use of personal protective equipment. Risk sheet for each job. Printed forms and forms. Manuals for the use of consoles or computer terminals used in different printing systems. Technical safety sheets for materials, products and raw materials. Plans of the facilities. Product handling standards. Occupational risk prevention plan.

UNIT OF COMPETENCE 8: Technologies and knowledge of materials for 3D printing.

Level 3
Code UC0008_3

Professional achievements and implementation criteria

RP1: Identify the processes of obtaining metallic materials from the study of their properties.

CR1.1 The alloy of the metallic materials and their properties is differentiated by the alloying elements as well as by their constituents through an analysis of their composition.
CR1.2 Changes in constituents of metallic materials differ in phase diagrams, especially iron-carbon.
CR1.3 Metal semi-finished products are distinguished by their shapes and dimensions relating to the established standards.
CR1.4 Alloys are classified through the analysis of their properties for their industrial applications.
CR1.5 The constitution of metallic composite materials is related to defined properties.

RP2: Identify manufacturing processes or transformation of non-metallic materials (polymeric, ceramic, composite, among others) by studying their properties.

CR2.1 Non-metallic materials are distinguished by their shapes and dimensions relating to manufacturing processes or transformation.
CR2.2 The most important polymeric and composite materials are identified through their components and their properties through the study of their manufacturing or transformation processes.
CR2.3 The most important construction materials (concrete, among others) are identified through their components and their properties through the study of their manufacturing or transformation processes.
CR2.4 The most important glass and ceramic materials are identified through their components and their properties through the study of their manufacturing or transformation processes.
CR2.5 The constitution of the elaborated materials of biological origin (paper, wood and cork, skin, among others) is related to properties through the study of their manufacturing or transformation processes.

RP3: Differentiate the processes of subsequent elaboration of metallic materials according to their complexity and the influence of the process on their behavior.

CR3.1 Metallic semi-finished products are identified by their finishes and shapes, associating them with the 3D printing process they have been subjected to.
CR3.2 The manufacturing processes of metallic materials are related to the mechanical properties of the products obtained.
CR3.3 The applications of the final product and the materials used in the realization of a fusion of metallic materials are identified by the process used.
CR3.4 The heating treatments applied to metallic products are established according to the final physical properties of the material.
CR3.5 Surface treatments applied to metallic products are established based on the final physical properties of the material.

RP4: Differentiate the processes of subsequent elaboration of non-metallic materials (polymeric, ceramic, composite, among others) according to their complexity and the influence of the process on their behavior.

CR4.1 Non-metallic semi-finished products are identified by their finishes and shapes, associating them with the transformation processes or other treatments to which they have been subjected.
CR4.2 The processes of elaboration of construction materials are related to the mechanical properties of the products obtained.
CR4.3 The processes of elaboration of glass and ceramic materials are related to the mechanical properties of the products obtained.
CR4.4 The manufacturing processes of textile and leather materials are related to the mechanical properties of the products obtained.
CR4.5 The processes of transformation of wood materials are related to the mechanical properties of the products obtained.
CR4.6 The transformation processes of polymeric materials are related to the mechanical properties of the products obtained.

RP5: Identify anomalies, discontinuities, or expected inhomogeneities that occur in materials and products, and the processes that originate them.

CR5.1 The discontinuities found in the different materials are related to the alterations of their components and processing processes.
CR5.2 The processes of surface wear, structural fatigue and aging of materials are identified by the working conditions to which they have been subjected.
CR5.3 The discontinuities produced in a material during the fusion are related to those associated to each fusion process.
CR5.4 Corrosion deterioration processes in a material are related to the existing environmental and working conditions.
CR5.5 Discontinuities such as delaminations, voids, pores and inclusions are identified with the processes of elaboration of composite materials.
CR5.6 The anomalies found in materials of biological origin are related to alterations produced by natural physical means of their components or by microorganisms.

Professional context

Means of production

Catalog of materials and products: catalog of materials and metal products, catalog of materials and construction products, catalog of plastic products, catalog of products of derivatives of natural origin such as wood, paper, cork, textiles, leather, among others.
Diagrams and standards of materials and products: balance diagrams of alloys and norms of classification of materials and products. Equipment for the recognition of materials: metallographic microscope, binocular loupes, magnifiers, chemical reagents and auxiliary equipment for the preparation of metallographic samples, electrolytic buckets, metallographic polishers, cutting machines, equipment for visualization and treatment of images, among others. Environmental and thermal equipment: furnace for thermal treatment, thermometer, thermocouples, hygrometer, among others. General equipment: gauges, millimeter rules, graph paper, consumables, among others. Computers and computer programs for data processing. Personal protection equipment (EPIs).

Products and results

Design scales and metallographic graphs. Elaborate macrographs. Revise laboratory inventory. Report constitution of alloy elements. Protection systems used. Products manufactured in composite, microfusion, metallic materials, among others used. Reports and graphics of microfusioned unions. Waste management.

Used or generated information

Report of composition of materials. Manuals or atlases of defects or imperfections. Norms and catalogs of commercial products. Documentation of chemical products and reagents and equipment manuals. Product safety sheets and chemical reagents. Graphics, tables and reports related to the existence of defects of the parts in manufacturing processes. Photographs and videos of defects or imperfections.

FORMATIVE MODULE 6: Assembly and maintenance of 3D printing systems.

Level 3
Code: MF0006_3
Associated to UC: Manage and supervise the assembly and maintenance of 3D printers, in industrial, personal and social environments.

Lenght: **Hours**

Capacities and evaluation criteria

C1: Analyze the technical information required for the assembly of 3D printers, extracting the necessary information to perform it, complying with the required technical and security specifications.

CE1.1 Identify and interpret the symbology and technical characteristics that are related to the assembly process of 3D printing systems.
CE1.2 Identify the different views and sections of the elements and assemblies of 3D printing equipment constructions.
CE1.3 Describe the assembly process and the means, tools and tools to be used in it.
CE1.4 From a plan or assembly process of a representative 3D printing system, it must:
- Identify and interpret the technical specifications provided by the plan.
- Identify and interpret the cutting plans, characterizing the different elements that make up the set and its dimensions and dimensions.
- Evaluate the quality requirements and tolerances required for assembly.
- Define the relative position of the elements and sets and identify the functionality of the set.
- Identify and characterize operations and processes involved in the assembly by determining the means and equipment necessary to carry it out.
- Establish the order or sequences of the assembly to be made.
- Establish the aspects required by the occupational and environmental risk prevention plan.
- Establish a distribution plan in the plant: provision of auxiliary means, storage areas and, in general, how many needs must be met to prepare the assembly area.
- Establish access needs according to the assembly to be made.
- Evaluate the defined assembly process.
- Present the information necessary for assembly in an orderly and sequenced manner.

C2: Prepare the work area for the assembly of 3D printing systems (equipment, tools, auxiliary means and work protections), based on the technical information provided, applying the plan for the prevention of occupational and environmental risks.

CE2.1 Describe the machines, equipment, accessories and auxiliary services necessary to carry out the assembly work.
CE2.2 Identify and characterize the materials necessary for the assembly work.
CE2.3 Characterize the work areas according to the type of assembly to be made.
CE2.4 Describe the plan for the prevention of occupational and environmental risks.
CE2.5 **In a practical case** where there is a documentation that defines the assembly of a representative 3D printing system, the following should be done:
- Collect the necessary material to make the assembly.
- Select the necessary equipment, tools, tools and auxiliary services.
- Check that the equipment, tools and tools are in good condition and perform the maintenance of use.
- Select the location of the assembly according to its dimension, the auxiliary means, its position and orientation in the work area.
- Apply environmental prevention and protection measures throughout the process.

C3: Assemble and install 3D printing systems: Align, position and assemble elements and structures from the "assembly process", complying with the plan for prevention of occupational and environmental risks.

CE3.1 Describe the means and equipment of measurement and leveling that are used in the assemblies.
CE3.2 Describe the different auxiliary means of assembly and repair specifying its constitution and use.
CE3.3 Identify, interpret and use the control signals used in the handling of equipment and auxiliary means.

CE3.4 Relate the elements of the installation with the function they perform and their applications.
CE3.5 Identify the location of the elements of the installation according to the areas of application and using the appropriate symbology, from the execution process.
CE3.6 **In a practical case** where a process of assembly or repair of a representative 3D printing equipment is available, and once the work area is prepared to proceed with the assembly and installation of the whole or part of it, the following should be done:

- Apply communication and collaboration techniques to perform teamwork.
- Identify the referential elements of position and form of the set.
- Rethink the elements and sub-assemblies according to the assembly process.
- Select the necessary measurement and leveling elements.
- Select equipment, and auxiliary assembly tools.
- "Apply" and level the elements of the structure of the 3D printer, leaving them presented according to specifications.
-"Rigidize"the assembly appropriately, maintaining specified limits and tolerances.
- Verify that the measurements of the assembly coincide with those indicated in the drawing and the dimensions and tolerances are as specified.
- Select and install the necessary auxiliary means to carry out the assembly.
- Use the standard command signals, when handling equipment and auxiliary means.
- Handle the machines, tools and auxiliary means used in the assembly.
- Verify the parameters, alarms, securities, interlocks, movements, among others, of the installation by contrasting the values obtained with those specified in the technical documentation.
- Describe the operating logic of the installation according to the elements that make up each circuit, using the electrical diagrams and checking it through the functional analysis of the installation.
- Verify that the sensors, control equipment, actuators and auxiliary elements that make up the installation meet the requirements established in the documentation of the same.
- Determine the variation that occurs in the operation of the installation assuming changes in the parameters of the elements and checking functionally on the installation.
- Use the means of personal protection and the environment required by the plan for the prevention of occupational and environmental risks.
- Apply the rules of use of equipment and media.

C4: Perform operational tests and start-up operations of equipment and elements of a 3D printing system, based on the technical documentation.

CE4.1 Select the necessary documents for the start-up of the equipment and elements of the installation (start-up protocols, manufacturer's manual, among others) from the technical documentation.
CE4.2 Describe the phases to be followed in the start-up of different equipment and elements of the installation according to their technical complexity.
CE4.3 **In a practical case** of start-up of equipment and elements of a system of a 3D printer, based on the technical documentation:

- Check that the installation complies with what the technical documentation indicates.
- Carry out commissioning according to the technical manual.
- Prepare a report of the activities developed and results obtained.

C5: Analyze and apply predictive or preventive maintenance techniques in 3D printing systems, based on technical documentation and acting under personal safety rules and the materials used.

CE5.1 Identify the parts and elements that make up the facilities analyzing the operation, characteristics, maintenance needs and applicable regulations.
CE5.2 Relate the elements of the installation with the function they perform and their applications.
CE5.3 Describe the parts of the installation that can be maintained, as well as the types of maintenance of
CE5.4 Select and prepare the materials, equipment, tools and documentation necessary to perform the tasks
CE5.5 Describe the procedures of each of the predictive maintenance operations that must be performed on the equipment and elements of an installation based on the 3D printing equipment to be maintained and according to the maintenance plan.
CE5.6 **In a practical case** of preventive maintenance of a type 3D printing installation, and from the technical documentation:

- Identify the elements on which preventive maintenance operations should be carried out.
- Identify the waste management plan.
- Identify the risk factors, the associated risks and the measures to be adopted.
- Prepare the work area according to the requirements of the operation according to established procedures.
- Check the general condition of supports, fixings, protections, elements, insulation, among others.
- Carry out cleaning operations and check the absence of deformations in equipment, installations and accessories.
- Check the power supply of the equipment and the connections and continuities of cables, connectors, power strips, among others, of electrical and communication systems of the 3D printing installation.
- Check the performance of the safety elements and protections.

- Check the status of the infrastructure of the installation (electrical, pneumatic and hydraulic).
- Check the parameters of the system and the equipment and compare the measurements obtained with the technical documentation, checking its correct operation.
- Review and maintain the equipment and tools used in maintenance in the operating state.
- Replace the element or component indicated in the maintenance plan, making the necessary interventions for this replacement.
- Carry out the necessary tests and adjustments according to the specifications in the technical documentation.
- Complete the intervention report by collecting the operations carried out in the established format.

C6: Apply corrective maintenance techniques in 3D printing systems based on technical documentation.

CE6.1 Describe the common faults that occur in 3D printing systems, determining the cause of them and their effects on the system.
CE6.2 Describe the procedures of each of the corrective maintenance operations that must be performed on the equipment and components of the facilities in the most common faults.
CE6.3 Describe the tools and equipment used in corrective maintenance operations, indicating the manner
CE6.4 **In a practical case** of diagnosis and troubleshooting of a type 3D printing installation, and from the technical documentation:

- Interpret the symptoms of the fault by relating it to the elements of the system.
- Carry out hypotheses of the possible causes of the fault describing the relationship between the effects described and the causes of them.
- Carry out an intervention plan to detect the cause or causes of the breakdown.
- Identify the waste management plan.
- Indicate the tests, measurements and verifications that should be carried out, specifying the procedures, equipment and technical and safety means that must be used.
- Replace the element or component responsible for the fault, making the necessary interventions for this replacement.
- Carry out the necessary tests and adjustments according to the specifications of the installation documentation.
- Write a report of the activities carried out and the results obtained.

Capacities whose acquisition must be completed in a real working environment

C1 regarding CE1.4; C2 regarding CE2.5; C3 regarding CE3.6; C4 regarding CE4.3, C5 regarding CE5.6; C6 regarding CE6.4.

Other Capacities:

Adapt to the organization of the company by integrating into the system of technical-labor relations. Correctly execute the instructions you receive, taking responsibility for the work you do, communicating effectively with the right person at all times.
Show an attitude of respect towards the companions, procedures and rules of the company.
Assume responsibility for the work that is carried out and the fulfillment of the objectives.
Propose alternatives with the objective to improve results.
Recognize the productive process of the organization.
Participate and collaborate actively in the work team.
Getting used to the pace of work of the company.
Adapt to the organization, to its organizational and technological changes as well as to new situations or contexts.

Contents:

1.- Graphic interpretation for the assembly of constructions of structures and elements of 3D printing systems

1.1.- Interpretation of plans and diagrams in the installations of specific assemblies and sub-assemblies. Electric schemes. Pneumatic and hydraulic diagrams. Process diagrams (P & I). Sketch of distribution and implementation plans.

1.2.- Assembly manuals of equipment and elements.

1.3.- Quality regulations, waste management and safety and prevention of occupational risks.

1.4.- Symbology used in the technical documentation in assembly of structures and elements of 3D printing systems.

2.- Elements and equipment for leveling elements and subassemblies, tools and standard tools for the assembly of 3D printing systems.

2.1.- Leveling equipment; plumb equipment; Leveling and plumb processes.

2.2.- Positioning elements; tools; auxiliary assembly elements; lifting and transport machinery; cats, tensioners; tools for screwing, riveting, etc ...

2.3.- Analysis and study of the structures of 3D printers:

- Constructive characteristics of the knots.

3.- Pneumatic and hydraulic, electrical and electronic elements and equipment for the assembly of 3D printing systems.

3.1.- Pneumatic and hydraulic elements:

- Tires: production and treatment of air, distributors, valves, pressure switches, cylinders, pneumatic motors, vacuum, among others. Standardized symbology.
- Hydraulic: Hydraulic group, distributors, hydro valves, servo valves, pressure switches, cylinders, hydraulic motors, accumulators, among others. Standardized symbology.

3.2- Electrical and electronic elements:

- Power supply network, electrical cabinets, command and control desks, wiring, sensors, actuators, among others Technologies applied in automation: wired logic and programmed logic.
- Types of controls of a process: open loop or closed loop.
- Types of applicable industrial processes.
- Electrical switchgear: contactors, switches, relays, among others.
- Detectors and sensors. Field instrumentation: instruments for measuring flow pressure, level and temperature, among others.
- Control equipment: analog regulators and digital regulators. Actuators: starters, variators, regulation and control valves, motors, among others.
- Cables and driving systems: types and characteristics. Elements and electrical safety equipment. Standardized symbology.

4.- Assembly techniques:

4.1.- Assembly of elements of machines:

- Elements of transmission. Couplings Bearings Clutches and brakes. Belts, pulleys, chains, cogwheels, among others. Control cables. Mechanical and manual tools of the specialty. Equipment and tools.

4.2- Assembly of pneumatic and hydraulic circuits:

- Pneumatic elements. Structure of pneumatic circuits. Types of controls in pneumatic circuits. Sequential hydraulic and pneumatic circuits. Assembly of the different elements of the pneumatic circuit: tanks, valves, actuators, pipes, accumulators, among others.
- Hydraulic elements Structure of hydraulic circuits. Types of controls in hydraulic circuits. Hydraulic circuits. Assembly of the different elements of the circuit: tanks, valves, actuators, pipes, among others.

4.3.- Assembly of mechanical and electrical mechanisms:

- Assembly of: reducers, linear to circular motion transformers and vice versa, clutches, brakes, gear trains, pulleys, couplers of transmission shafts, bearings, bearings, cams, springs,

connecting elements, control cables, among others. Sliding surfaces: Guides, columns, bushes, trolleys. Sealing gaskets. Assembly of mechanical, electrical, hydraulic, pneumatic equipment or assemblies, among others. Installation of cable bundles. Connection of terminals and wire bundles.

4.4.- Attachements and union techniques:

- Techniques of manual and machine machining. Braking. Sealing. Joints between rigid / flexible pipes. Curved and flared tubes. Placement of electrical terminals. Normalization and specific identification of the elements of union. Bolts, nuts bolts and bolts. Washers and pins. Flanges and broaches. Fittings. Separators, electrical terminals. Special binding elements.

5.- Functional tests and start-up of 3D printing equipment:

5.1.- Measurement, adjustment and control devices.

5.2.- Verification of:

- Parameters.
- Alarms, securities and interlocks.
- Monitoring and visualization system.

5.3.- Protocols of:

- Tests, Adjustments and regulation.
- Start-up of equipment and field elements.
- Start-up of control and visualization equipment.

5.4.- Protection equipment.

5.5.- Assembly and commissioning reports.

6.- Types of maintenance of 3D printing equipment

6.1.- Predictive and preventive maintenance:

- Established procedures.

6.2.- Substitution of elements according to their average life:

- Mantenimiento correctivo.
- Scheduled repair:
  - Established procedures.

7.- Maintenance techniques of 3D printing equipment

7.1.- Types of breakdowns.

7.2.- Tools, equipment, measuring instruments and auxiliary technical means.

7.3.- Diagnostic techniques:

- Tests, measurements and procedures.

7.4.- Maintenance ranges.

7.5.- Protection equipment.

8.- Regulations for the prevention of occupational risks and environmental protection applied to the assembly of 3D printing equipment:

8.1.- Risks evaluation.

8.2.- Techniques and protection elements

8.3.- Environmental management:

- Waste treatment

8.4.- Legislative and regulatory aspects.

Context parameters of the training

Spaces and Facilities

The spaces and facilities will respond, in the form of a classroom, classroom-workshop, practice workshop, laboratory or singular space, to the training needs, in accordance with the Professional Context established in the associated Competition Unit, taking into account the applicable regulations of the productive sector, risk prevention, occupational health, universal accessibility and environmental protection.

Professional profile of the trainer:

1.- Mastery of knowledge and techniques related to the assembly and maintenance of 3D printing systems and equipment, which will be accredited by one of the following forms:

- Academic formation of Technical Engineer, degree of equivalent degree or of other higher level related to this professional field.
- Professional experience of at least 3 years in the field of competences related to this training module.

2.- Pedagogical competence accredited in accordance with what the competent Administrations establish.

FORMATIVE MODULE 7: 3D Printing

Level 3
Code: MF0007_3
Associated to UC: Use 3D printers to obtain final products.
Lenght: hours

Capacities and evaluation criteria

C1: Determine and apply the methods of processing digital information, using software appropriate to the needs of the 3D printing process.

CE1.1 Interpret the methods and rules established in the reception of the original files used in 3D printing.
CE1.2 Verify that the content of the digital files corresponds to the technical specifications of the product.
CE1.3 **In a practical case** of receiving files for 3D printing, check:
- The files of 3D models: file names, avoid duplicate files, suitable file formats and others (resolution, mode and color).
- Information storage media: CDs, DVDs, diskettes, external hard drives, virtual spaces, servers, among others.

CE1.4 Identify computing equipments and programs required for the digital information of the design.
CE1.5 Interpret the operation and characteristics of computer equipment and software based on the interpretation of technical documentation and user manuals.
CE1.6 Determine the causes that motivate the deviations of the characteristics of the 3D design, in relation to the process followed, to take timely corrective measures that allow us to obtain the quality specified in a given work order.
CE1.7 **In a practical case** of processing information from different files:
- Identify the computer format and characteristics to adapt it to the technical specifications, by using the appropriate software.
- Establish the appropriate file formats.
- Optimize the parameters of the images in relation to the needs of 3D printing.
- Store the optimized digital files, using the available software that guarantees the inalterability of the content.

CE1.8 Recognize the most appropriate software of the content of the digital file for delivery to the 3D printing machine.
CE1.9 In a practical simulation of preparing files to be sent to print to the machine, from design files, we will:
- Select the appropriate software that allows the opening of validated digital files for the introduction of parameters and technical characteristics in the 3D printing system, (software for treatment of designs, software to determine printing parameters and others).

CE1.10 Relate the current 3D printing systems with different elements to be printed.
CE1.11 **In a practical case** of valuation of different 3D printing systems, from some given models:
- Set the calibration of the printing system for the given models.
- Relate the print quality of the 3D models in the different existing 3D printing systems.
- Contrast the relationship between the elements obtained and their designs.

C2: Recognize and analyze the main properties and characteristics of raw materials and auxiliary products, as well as the quality variables used in 3D printing.

CE2.1 Recognize and describe the main characteristics, physical-chemical properties and structure of the materials used in 3D printing.
CE2.2 Characterize the main defects and alterations of the different materials used in 3D printing.
CE2.3 Relate the properties of the materials with the behavior requirements in the different processes.
CE2.4 Identify the risks and level of danger involved in handling the different materials and products used in 3D printing.
CE2.5 Relate the durability and behavior of the different 3D printing products with the alterations they suffer, due to: humidity, temperature, property of the materials, oxidation, exposure to light and mechanical stress.
CE2.6 **In a practical case** of assessment of the quality of raw materials, from different measuring equipment (precision, densimeter, colorimeter, spectrophotometer and others):
- Check the characteristics of the printed elements.
- Assess the quality of raw materials and correctly express the results of the measures.
- Determine optimal storage conditions for raw materials.

C3: Perform the operations of commissioning and setting up of the main machines and 3D printing equipment, to make the printing with the required quality.

CE3.1 Describe the different 3D printing systems that are currently used.
CE3.2 Analyze the regulatory operations necessary to adjust the 3D printing process, according to the type of machine to be used.
CE3.3 Explain the different methods of checking and regulation in 3D printing machines.
CE3.4 **In a practical case** of adjustment of a 3D printing machine, from a work order properly characterized, regulate all configurable parameters.
CE3.5 In a case of maintenance of 3D printer, from the maintenance sheet of the machine:
- Identify the elements that must be maintained.
- Define the appropriate first level maintenance plan for the 3D printing machine.
- Carry out the maintenance operations methodically: greasing, cleaning dry grease, cleaning dust remains, following the manufacturer's instructions.
- Carry out methodical cleaning of the machine complying with the applicable regulations for the prevention of occupational and environmental risks.

CE3.6 Identify the appropriate way to arrange the materials in the machines, in order to obtain the optimal results and times.
CE3.7 Describe the defects of the 3D printing system.
CE3.8 **In a practical case** of adjustment of elements of 3D printing machines, from a type job to be printed:
- Relate the causes and effects of the readjustment of the parameters on the printed model.
- Acting manually or using computer equipment, the parameters adjusting them to the needs.

CE3.9 **In a practical case** of 3D printing, from the original design and prepress tests:
- Obtain the printed element with the required quality in relation to the original design.
- Compare the printed element with the prepress tests, readjusting the parameters of the same.
- Match the machines and raw materials used with the printing speed, according to the parameters of the printed element.

C4: Relate the measurement of the products obtained in 3D printing with the quality variables of the process, using the appropriate instruments.

CE4.1 Describe the method and frequency of obtaining samples for verification during the production of a series of 3D printed pieces.
CE4.2 Carry out the measurement on elements printed in 3D, using the appropriate instruments and expressing the result of the measurement in the units and in an appropriate way.
CE4.3 **In a practical case** of a process to measure the quality variables of 3D printed elements:
- Relate the different elements that intervene in a series of control with the deviation of the required quality parameters.
- Identify, describe and, where appropriate, represent the defects that must be controlled during production.
- Identify the control devices that must be used.

CE4.4 Identify the risks and level of danger involved in handling the different materials, products and equipment used in 3D printing.
CE4.5 Relate the products and materials used in 3D printing, with the environmental regulations, considering the substitutes of the products traditionally used that adapt to said regulations.
CE4.6 **In a practical case** of 3D printing characterized by the operations that must be carried out:
- Identify and describe the security mechanisms of printing machines: stop buttons, protections, housings, grids, as well as the means of protection and clothing that should be used.
- Describe the safety conditions in the preparation and maintenance operations of the machines.
- Establish the safety and precaution measures that must be adopted, according to the applicable regulations for the prevention of occupational and environmental risks and the specific instructions of the equipment applicable to the different operations.

C5: Analyze occupational and environmental risk prevention plans and the corresponding applicable regulations to correctly use means, equipment and materials in the realization of 3D printing.

CE5.1 Relate and describe the rules regarding the cleanliness and order of the work environment in 3D printing.
CE5.2 Describe the properties and uses of the most commonly used personal protective clothing and equipment for 3D printing.
CE5.3 Identify and describe standards for stopping and manipulating 3D printing systems and machines.
CE5.4 Relate the materials used in 3D printing with the environmental regulations, considering the substitutes of the products used.
CE5.5 **In a practical case** of security assessment in 3D printing, based on a number of prevention plans for occupational and environmental risks of companies in the sector:
- Identify and describe the most relevant aspects of each plan, included in the documentation that contains it.

- Identify and describe the factors and situations of risk to health and safety in the plans related to that activity.
- Relate and describe the appropriate preventive measures and methods of prevention established to avoid accidents.

Capacities whose acquisition must be completed in a real working environment

C1 regarding CE1.3, CE1.7, CE1.9 y CE1.11, C2 regarding CE2.6, C3 regarding CE3.4, CE3.5, CE3.8 y CE3.9, C4 regarding CE4.3, y CE4.6, C5 regarding CE5.5.

Other capacities:

Assume responsibility for the work that is carried out and the fulfillment of objectives.
Demonstrate a certain degree of autonomy in the resolution of contingencies related to their activity.
Propose alternatives with the aim of improving results.
Communicate effectively with the right people at all times, respecting established channels.
Adapt to the organization, to its organizational and technological changes as well as to new situations or contexts.
Learn new concepts or procedures and take advantage of training effectively using the knowledge acquired. Respect the procedures and internal rules of the company.
Interpret and execute work instructions.

Contents:

1.- Receiving 3D design files

1.1.- Methods. Rules. Protection.
1.2.- Design files, (graphic formats in computer support, resolution, and color).
1.3.- Graphic tools.
1.4.- Information supports.

2.- Processing of the Information

2.1.- Equipment: classes, types, characteristics and operation.
2.2.- Viewing of files
2.3.- Software for treatment of designs; Software for workflow management.
2.4.- Simulations, pre-check, and digital tests. Types.
2.5.- 3D printing processes, classification; functioning; transfer of the image.
2.6.- Adjustment of parameters in 3D printing equipment.

3.- 3D printing processes

3.1.- Printing procedures.
3.2.- Types of technologies.
3.3.- Operations. Control parameters.
3.4.- Printing machines, characteristics, structures and types.
3.5.- Applicable regulations for the prevention of occupational and environmental risks.
3.6.- Protection measures.

4.- Preparation and commissioning of equipment for 3D printing

4.1.- Charger device.
4.2.- Parts: mechanisms and regulation.
4.3.- Measuring devices.
4.4.- Problems of the regulation of the machine. Solutions
4.5.- Safety regulations for machines, installations and materials.

5.- Production of the 3D printed model

5.1.- Manual or electronic readjustment of the mechanical elements of the equipment.
5.2.- Review of the printed element. Readjustment of the equipment parameters.
5.3.- Team speed relationship between raw materials and printing speed.
5.4.- Defects in 3D printing. Cause/correction
5.5.- Check of the printed element in 3D, with prepress tests.
5.6.- Factors and risk situations, personal protection equipment.

6.- Quality control during the prototyping process

6.1.- Computer programs and equipment for monitoring the quality of the printed model. Applications. Equipment for the control of the 3D printed model. Elements for control.
6.2.- Criteria to be followed in the quality control of the 3D printed model, conditions in the control process, lighting and observation angle.
6.3.- Control of the finished printed element, conditions of printability of the 3D model.
6.4.- Guidelines to follow in the inspection of 3D printed elements: sampling, reliability and measurement.
6.5.- Quality standards of the model printed in 3D.

7.- Maintenance operations

7.1.- First level maintenance.
7.2.- Lubricants: oils, fats.
7.3.- Cleaning sequence in 3D printing equipment.

8.- Safety and health in 3D printing processes. General risks and their prevention.

8.1.- Work and health: professional risks. Risk factor's.
8.2.- Damages derived from work. Accidents and occupational diseases. Other pathologies derived from work.
8.3.- Basic regulatory framework for occupational risk prevention.
8.4.- Elementary risk assessments: simple identification and assessment techniques.
8.5.- Security techniques: prevention and protection measures.
8.6.- Risks linked to security conditions. Risks linked to the work environment. Risks linked to the organization of work in 3D printing companies.
8.7.- Elements defined in the self-protection plan: fire protection equipment, emergency exits and others.
8.8.- Emergency situations and first aid in 3D printing processes.
8.9.- Action protocols and evacuation procedures in emergency situations.
8.10.- Basic techniques of action against accidents at work. First aid. Resources and necessary means.

9.- Analysis, evaluation and control of environmental risks in 3D printing processes

9.1.- Labor standards and procedures in the field of environmental protection.
9.2.- Risks related to environmental conditions. Risk's factors.
9.3.- Management of waste produced in the 3D printing process. Treatment of discharges.
9.4.- Legal requirements in environmental matters needed in 3D printing machines and equipment.
9.5.- Development of environmental protection plans in 3D printing companies.
9.6.- Analysis and evaluation of environmental risks linked to 3D printing processes.
9.7.- Research techniques of environmental incidents, causes and consequences.
9.8.- Preventive and corrective measures. Individual Protection Equipment.

9.9.- Products used in 3D printing processes: technical data sheets, instructions and labeling.
9.10.- Documentation and administrative procedures in environmental matters.

Context parameters of the training

Spaces and facilities

The spaces and facilities will respond, in the form of a classroom, classroom-workshop, practice workshop, laboratory or singular space, to the training needs, in accordance with the Professional Context established in the associated Competition Unit, taking into account the applicable regulations of the productive sector, risk prevention, occupational health, universal accessibility and environmental protection.

Professional profile of the trainer:

1. Domain of knowledge and techniques related to the interpretation and management of digital information necessary for 3D products printing, which will be accredited by one of two ways:
   - Level 3 academic training, technical engineering or other higher level linked to the professional field.
   - Professional experience of at least 3 years in the field of competences related to this training module.
2. Pedagogical competence accredited according to what the competent Administrations establish.

FORMATIVE MODULE 8: 3D Materials

Level 3

Code: MF0008_3

Associated to UC: Technologies and knowledge of 3D printing materials.

Lenght: hours

Capacities and evaluation criteria

C1: Recognize the manufacturing processes of metallic materials by studying their properties.

CE1.1 Relate the constituents of the alloys of metallic materials with the properties that it confers to the material.
CE1.2 Explain in a Fe-C diagram the points of change of the constituents and their relations with the properties of the material.
CE1.3 Establish a classification of metallic products based on commercial standards and catalogs, indicating their shape and dimensions.
CE1.4 Prepare a list of the alloys according to their industrial applications.
CE1.5 Select different composite materials according to their manufacturing process.
CE1.6 **In a practical case** of a sample of a metallic material, observe it under the metallographic microscope and classify the characteristics of the material.

C2: Recognize non-metallic materials or products (polymeric, ceramic, composite, among others) by studying their properties and relating them to manufacturing or transformation processes.

CE2.1 Classify different non-metallic materials by their shapes and dimensions relating them to their manufacturing or transformation processes.
CE2.2 Classify different polymeric and composite materials according to their components and properties.
CE2.3 Classify concretes according to their resistance by relating them to the proportion and characteristics of their constituent materials.
CE2.4 Classify different glass and ceramic materials according to their components and properties.
CE2.5 Distinguish different biological materials (paper, wood and cork, skin among others) and relate them to their properties.
CE2.6 **In a practical case** of a sample of a non-metallic material, prepare a sample, observe it and classify the characteristics of the material by their properties.

C3: Distinguish the processes of subsequent elaboration of metallic materials according to their complexity and the influence of the process on their behavior.

CE3.1 Link the mechanical properties to the materials with the 3D printing processes.
CE3.2 Identify the semi-finished metallic materials for their endings.
CE3.3 Distinguish the transformations that occur in the properties of a material through a thermal or thermochemical treatment.
CE3.4 Distinguish the transformations that occur in the surface property through a thermal or surface thermochemical treatment.
CE3.5 Identify the 3D printing process of a material according to its surface finish.
CE3.6 **In a practical case** of a sample of metallic material Printed in 3D, note the mechanical properties and compare it with the same material without printing.

C4: Distinguish the processes of subsequent elaboration of non-metallic materials (polymeric, ceramic, composite, among others) according to their complexity and the influence of the process on their behavior.

CE4.1 Distinguish semi-finished non-metallic products by their finishes and shapes, associating them with the transformation processes.
CE4.2 Prepare a list of the main construction materials and their mechanical properties, grouped by their production processes.

CE4.3 Distinguish the main glass and ceramic materials and their mechanical properties, according to their manufacturing processes.
CE4.4 Distinguish the main textile and leather materials and their mechanical properties, according to their manufacturing processes.
CE4.5 Distinguish the mechanical properties of wood materials, according to their transformation processes.
CE4.6 Distinguish the mechanical properties of polymeric materials, according to their transformation processes.

C5: Associate anomalies, discontinuities, or expected lack of uniformity that occur in materials and products with the processes that originate them.

CE5.1 Identify the discontinuities found in a material relating them to the alterations of its components and the alterations produced in its elaboration processes.
CE5.2 Relate the causes of surface wear, structural fatigue and aging of the materials according to the working conditions to which they have been subjected.
CE5.3 Prepare a list of discontinuities associated with the microfusion processes used.
CE5.4 Relate the environmental and work conditions with the corrosion deterioration processes of the materials and products.
CE5.5 Identify discontinuities such as delaminations, voids, pores and inclusions of composite materials produced in the manufacturing processes.
CE5.6 Identify the types of alterations produced by natural physical means of its components or by microorganisms in materials of biological origin.
CE5.7 **In a practical case** of vitreous materials identify the defects with the manual of defects and imperfections indicating the process in which they have occurred, such as the contamination of raw materials, the agitation in the refining, the melting temperature, among others.
CE5.8 **In a practical case** of a 3D printed piece of thermoplastic material, identify defects associating them with the processes that originated them, such as model design, extrusion temperature, resilience, among others.
CE5.9 **In a practical case** of a laminated piece of thermosetting material, identify defects associating them with the processes that originated them, such as delaminations, hollows, fiber-resin ratio, gelling time, among others.
CE5.10 **In a practical case** of a pavement made with bituminous mixtures identify defects associating them with the processes that have originated them, such as plastic deformations, disintegration, breakage by fatigue, among others.
CE5.11 **In a practical case** of a material obtained from skin, identify defects such as spots, discolorations, heterogeneities, among others.

Capacities whose adquisition must be completed in a real working environment

C5 regarding CE5.9, CE5.10, CE5.11, CE5.12 y CE5.13.

Other Capacities:
Assume responsibility for the work that is carried out and the fulfillment of objectives.
Demonstrate a certain degree of autonomy in the resolution of contingencies related to their activity.
Propose alternatives with the aim of improving results.
Demonstrate flexibility to understand changes
Adapt to new situations or contexts.
Learn new concepts or procedures and use the information obtained from the acquired knowledge efficiently.

Contents:

1.- Properties of metallic materials and their study through basic metallographic tests

1.1.- Classification. Metallic structural materials; advanced materials: composite materials and superalloys. Metals and alloys.
1.2.- The metallic state, basic principles of metallurgy, processes for obtaining metals.
1.3.- Physical and structural properties of metals. Technological properties Balance diagrams Properties of the alloys.
1.4.- Steel as Fe-C alloy: Classification and applications.
1.5.- Foundries: classification and applications.
1.6.- Light alloys: types, properties and applications.

1.7.- Other alloys.
1.8.- Metallographic constituents of low alloy steels and foundries.
1.9.- Testing tubes preparation. Features of basic destructive tests (metallographic, mechanical and other physical parameters).
1.10.- Types of reports of basic destructive tests.
1.11.- Environmental control of waste.

2.- Properties of non-metallic materials and products (polymeric, ceramic, composite) and their study by basic tests.

2.1.- Classification. Non-metallic structural materials: polymers and composites, construction materials, glass and ceramics, wood and cork, leather, among others.
2.2.- Polymers and compounds: types, compositions and their applications.
2.3.- Building materials: types, compositions and their applications.
2.4.- Materials from cement-concrete, prefabricated, materials made from baked clay, materials from natural stone, among others.
2.5.- Influence of the quality of the constituent materials and their proportions in the final products.
2.6.- Glass and ceramics: types, compositions and their applications.
2.7.- Wood and cork: types, compositions and their applications.
2.8.- Leather: types, compositions and their applications.
2.9.- Other types of materials.
2.10.- Preparation of test tubes. Characteristics of basic destructive tests. Types of reports of basic destructive tests.
2.11.- Environmental control of waste and its management.

3.- Processes of subsequent transformation of metallic materials and non-metallic materials (polymeric, ceramic and composite)

3.1.- General knowledge of metallic materials. Classification.
3.2.- Microfusion: processes, classification.
3.3.- Powder Metallurgy (Sintered).
3.4.- Coatings and surface treatments.
3.5.- Development of non-metallic materials.
3.7.- Composite materials.
3.6.- Heat treatments: hardening, tempering, annealing, isothermal treatments, cementation, sulfinization and nitriding.
3.7.- General notions of non-metallic materials (polymeric, ceramic and composite).
3.8.- Polymers and compounds: types, designs and their applications.
3.9.- Construction materials: setting and curing process.
3.10.- Glass and ceramics: Glass manufacturing processes due to their subsequent use.
3.11.- Wood and cork: Types of wood processing, cutting, among others.
3.12.- Leather: Types of processed.

4.- Recognition of anomalies, discontinuities or lack of homogeneity of materials, products and microfusion related to the processes that produce them.

4.1.- Typical discontinuities associated with metal fabrication processes: microfusion, powder metallurgy, thermal treatments, coatings, surface treatments, composite materials and other non-metallic materials.

4.2.- Operational defectology.

4.3.- Metal corrosion, main corrosion mechanisms: by pitting, by cavitation, intergranular, stress corrosion, fatigue corrosion.

4.4.- Fatigue of metals. Fatigue mechanisms, fatigue limit.

4.5.- Failure of metallic materials.

4.6.- Ductile break, fragile break.

4.7.- Metallography: sample preparation, chemical attack, reagents, polishing, microscope, metallographic and replicas.

4.8.- Notions of macro and micrography.

4.9.- Notions of metallography of non-ferrous materials.

4.10.- Typical discontinuities associated with non-metallic manufacturing processes.

Context parameters of the training

Spaces and facilities

The spaces and facilities will respond, in the form of a classroom, multipurpose classroom of a minimum of 2 m^2 per student, classroom-workshop, practice workshop, 45 m^2 test laboratory or singular space, to the training needs, in accordance with the Professional Context established in the associated Competition Unit, taking into account the applicable regulations of the productive sector, risk prevention, occupational health, universal accessibility and environmental protection.

Professional profile of the trainer:

1. Mastery of knowledge and techniques related to the recognition of the properties of materials and products associated with their manufacturing or transformation processes, which will be accredited by one of the following forms:
   - Academic education of Bachelor, Engineer, Architect, equivalent degree qualifications or other higher level related to this professional field.
   - Professional experience of at least 3 years in the field of competences related to this training module.
2. Pedagogical competence accredited in accordance with what the competent Administrations establish.