



## Structure of the course LAIT 4.0

### Day 1

<b>Module Title</b>	<b>Introduction to Industry 4.0</b>
<b>Hours</b>	7h
<b>Rationale and aims</b>	<p>This module is an introduction to Industry 4.0. It will clarify concepts around the paradigm and give an overall view of the technologies involved.</p> <p>It will stress the importance of new business models that are/will be appearing around the digital transformation of industry and the opportunities to impact greatly in the competitiveness of the companies.</p> <p>The module will train on a method to carry out a technological check-up at manufacturing companies based on a toolbox.</p> <p>It also will give hints on low cost approaches that can lead to affordable Industry 4.0 solutions in factories, especially in SMEs.</p> <p>Contents will be illustrated with several case studies.</p>
<b>Contents</b>	<p>The contents of this module are:</p> <ul style="list-style-type: none"><li>- Introduction</li><li>- Concepts</li><li>- Technologies</li><li>- New business models</li><li>- Companies' check ups</li><li>- Low cost Industry 4.0</li><li>- Case studies</li></ul>
<b>Learning Outcomes</b>	<p>The module attendees will be able to:</p> <ul style="list-style-type: none"><li>- Have an overall view on Industry 4.0</li><li>- Identify and distinguish technologies under the Industry 4.0 umbrella</li><li>- Know applications of each technology</li><li>- Identify new ways of impacting on business through digital transformation</li><li>- Know how to perform a technological check-up in manufacturing companies</li><li>- Identify HW/SW products and services that allow low cost</li></ul>



	solutions for industries
<b>Methodology</b>	<p>A combination of methods will be used to allow active participation of course attendees:</p> <ul style="list-style-type: none"><li>- Theoretical concepts will be explained by the teacher</li><li>- The teacher will deliver several articles on Industry 4.0 and promote the active participation/discussion</li><li>- A case will be proposed so that attendees practice on technological check-ups</li><li>- A visit to IK4-TEKNIKER's shop floor and labs will be made to give an overall overview on Industry 4.0 applications</li></ul>
<b>Resources</b>	<p>Resource to be used within the module:</p> <ul style="list-style-type: none"><li>- Videos</li><li>- Articles, written material</li><li>- Demo (visit)</li></ul>



Day 2

Module Title	Sensing
Hours	7h
Rationale and aims	<p>Manufacturing environment is more and more sensorized with the objective of gaining more information from it. One of the most challenging examples of sensorizing, particularly in Industry 4.0, is the inspection and measurement in process, machine and in-line (Metrology 4.0).</p> <p>This module tackles how such “on-line” inspections can be performed through sensorizing, explaining challenges and benefits. Theoretical and practical explanations will be made, including visits to the shop floor and metrology lab.</p>
Contents	<p>The contents of this module are:</p> <ul style="list-style-type: none"> <li>- Introduction to equipment’s sensorizing</li> <li>- Sensorizing for inspection/measurement (Metrology 4.0):               <ul style="list-style-type: none"> <li>o In process</li> <li>o In machine</li> <li>o In-line</li> </ul> </li> <li>- Demos/visit to shop floor:               <ul style="list-style-type: none"> <li>o Sensorized machine (Twin-Control)</li> <li>o Metrology (inspection in machine)</li> </ul> </li> </ul>
Learning Outcomes	<p>The module attendees will be able to:</p> <ul style="list-style-type: none"> <li>- Know the steps to sensorize an equipment</li> <li>- Know different existing types of sensors</li> <li>- Distinguish among measurement in process, in machine, in line and their applications, challenges and benefits.</li> </ul>
Methodology	<p>A combination of methods will be used to allow active participation of course attendees:</p> <ul style="list-style-type: none"> <li>- Theoretical concepts will be explained by the teacher</li> <li>- The teacher will deliver several articles on metrology 4.0 and promote the active participation/discussion</li> <li>- Visits to IK4-TEKNIKER’s shop floor and lab will be made to show two case studies, one of them to showcase a sensorized machine (machine tool as a Cyber-Physical System), and a second one to showcase inspection/measurement in machine</li> </ul>



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<b>Resources</b>	Resource to be used within the module: <ul style="list-style-type: none"><li>- Videos</li><li>- Articles, written material</li><li>- Demos (visits). It includes two visits to the shop floor and lab to show different cases studies</li></ul>
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Day 3

<b>Module Title</b>	<b>IoT Platforms/Data Analytics</b>
<b>Hours</b>	7h
<b>Rationale and aims</b>	<p>This module is focused on IoT platforms, cloud computing, Big Data and advanced analytics, M2M communication and cybersecurity.</p> <p>IoT platforms' market will be reviewed and IoT concepts and applications will be explained.</p> <p>Introduction to Cloud computing and Big Data and a review on advanced data analytics will be done.</p> <p>A review on M2M communication and considerations on cybersecurity will be explained.</p> <p>IoT and advanced analytics concepts will be shown in a particular case study.</p>
<b>Contents</b>	<p>The contents of this module are:</p> <ul style="list-style-type: none"> <li>- IoT platforms (concepts, applications, state-of-the-play...)</li> <li>- SAM – Smart Asset Management (IK4-TEKNIKER's IoT platform)</li> <li>- Introduction to Cloud computing and Big Data</li> <li>- Advanced analytics (data mining, machine learning...)</li> <li>- M2M and standardized communications (e.g. OPC UA)</li> <li>- Cybersecurity</li> <li>- Demo/Visit: Atten2</li> </ul>
<b>Learning Outcomes</b>	<p>The module attendees will be able to:</p> <ul style="list-style-type: none"> <li>- Know main concepts on IoT, have a clear view on its applications and identify the currently market winning platforms within the myriad of commercial systems</li> <li>- Know the basic infrastructure of an IoT platform</li> <li>- Know main concepts on Cloud computing and Big Data</li> <li>- Identify key techniques for advanced analytics</li> <li>- Identify key M2M communication protocols, specifically OPC UA</li> <li>- Know basic ideas on cybersecurity</li> </ul>
<b>Methodology</b>	<p>A combination of methods will be used to allow active participation of course attendees:</p> <ul style="list-style-type: none"> <li>- Theoretical concepts will be explained by the teacher</li> <li>- The teacher will deliver several articles on the diverse topics and promote the active participation/discussion</li> </ul>



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	<ul style="list-style-type: none"><li>- Visit to IK4-TEKNIKER's lab will be made to show a case study that applies IoT and advanced analytics with a smart device that performs oil analysis for wind turbines</li></ul>
<b>Resources</b>	Resource to be used within the module: <ul style="list-style-type: none"><li>- Videos</li><li>- Articles, written material</li><li>- Demo (visit). It includes a visit to the lab to show a case study</li></ul>



#### Day 4

<b>Module Title</b>	<b>Flexible and collaborative robotics</b>
<b>Hours</b>	7h
<b>Rationale and aims</b>	<p>This module is focused on flexible robotics, and especially on collaborative robotics, one of the key technologies related to Industry 4.0.</p> <p>Commercial solutions will be shown and the state-of-the-art in technologies around collaborative robotics will be explained. Features that are required to make a robot collaborative will be taught.</p> <p>Experimentation with robotics at lab level will be carried out.</p>
<b>Contents</b>	<p>The contents of this module are:</p> <ul style="list-style-type: none"><li>- Introduction to Flexible and Collaborative robotics. Technologies involved and applications</li><li>- Technology capability requirements<ul style="list-style-type: none"><li>o Autonomy and adaptation</li><li>o Perception</li><li>o Safety, interaction &amp; usability</li><li>o Mechatronic systems</li></ul></li><li>- Case studies</li><li>- Visit to robotics lab/shop floor (experimentation and interaction with robotics solutions)</li></ul>
<b>Learning Outcomes</b>	<p>The module attendees will be able to:</p> <ul style="list-style-type: none"><li>- Know the state-of-the-play on robotics solutions</li><li>- Know the state-of-the-art in technologies for collaborative robotics solutions</li><li>- Identify advanced and flexible robotics systems (conventional, collaborative and service robotics) and their applications</li><li>- Identify required features and the technologies involved to create a collaborative robotics solution:<ul style="list-style-type: none"><li>o Perception</li><li>o Interaction</li><li>o Safety</li><li>o Autonomy</li><li>o Adaptation</li></ul></li></ul>
<b>Methodology</b>	<p>A combination of methods will be used to allow active participation of course attendees:</p>



	<ul style="list-style-type: none"><li>- Theoretical concepts will be explained by the teacher</li><li>- The teacher will deliver several articles on flexible and collaborative robotics and promote the active participation/discussion</li><li>- Visits to IK4-TEKNIKER's shop floor and robotics lab will be made to show different solutions and applications on collaborative robotics. The visits will be made from a practical perspective. Attendees will be able to interact with robots</li></ul>
<b>Resources</b>	<p>Resource to be used within the module:</p> <ul style="list-style-type: none"><li>- Videos</li><li>- Articles, written material</li><li>- Demos (visit). It includes several robotics demos on the shop floor and the robotics lab</li></ul>





Day 5

<b>Module Title</b>	<b>Additive manufacturing Summary and conclusions</b>
<b>Hours</b>	7h
<b>Rationale and aims</b>	<p>Additive manufacturing is a technology included within Industry 4.0. In this module, the concept will be explained and the different technologies involved analysed, focusing especially in metallic materials and composites (SLM, DMLS...).</p> <p>Applications of additive manufacturing will be analysed.</p> <p>As specific additive manufacturing process, laser cladding will be introduced and explained and experimentation on the shop floor with the process will be performed.</p> <p>To conclude the course, a new exercise with the technological check-up of companies will be proposed and a summary of the concepts explained during the whole course will be given for consolidation.</p>
<b>Contents</b>	<p>The contents of this module related to additive manufacturing are:</p> <ul style="list-style-type: none"> <li>- Additive manufacturing (concepts, benefits, applications...)</li> <li>- Laser processes (laser cladding)</li> <li>- Visit to the shop floor</li> <li>- Practice: How to create a new part by an additive process</li> </ul> <p>Other contents of this module:</p> <ul style="list-style-type: none"> <li>- Technological check-up new practice</li> <li>- Hints on how to prepare the one day course</li> <li>- Conclusions</li> </ul>
<b>Learning Outcomes</b>	<p>The module attendees will be able to:</p> <ul style="list-style-type: none"> <li>- Know the state-of-the-art in additive manufacturing</li> <li>- Identify the wide range of additive manufacturing processes and the related technologies</li> <li>- Know a deep insight on laser cladding process, its applications and benefits</li> <li>- Know how to design and execute a laser cladding process</li> </ul> <p>Besides, the attendees will learn deeper on how to carry out a technological check-up at companies.</p>
<b>Methodology</b>	A combination of methods will be used to allow active participation of



	<p>course attendees:</p> <ul style="list-style-type: none"><li>- Theoretical concepts will be explained by the teacher</li><li>- The teacher will deliver several articles on additive manufacturing and promote the active participation/discussion</li><li>- Visit to IK4-TEKNIKER's shop floor will be made to show the laser cladding infrastructure. The visit will include a practice to design and execute an additive process to create a new part</li><li>- A case will be proposed so that attendees practice on technological check-ups</li></ul>
<b>Resources</b>	<p>Resource to be used within the module:</p> <ul style="list-style-type: none"><li>- Videos</li><li>- Articles, written material</li><li>- Demos (visit). It includes the design and execution of an additive process</li></ul>