

CM4 Green Design and Sustainable Manufacturing

LEARNING OBJECTIVES

The Green Design and Sustainable Manufacturing track aims to educate and train a new breed of professionals grounded in mechanical and industrial engineering skills and specialized in sustainable development and digitalization. These skills are increasingly crucial for industrial companies as they embark on the trajectory outlined by the 2030 UN Agenda for Sustainable Development and the European Green Deal. We aim to facilitate the transition towards a new era of green products and promote circular and sustainable manufacturing practices.

LEARNING OUTCOMES

Upon successfully completing the Green Design and Sustainable Manufacturing track, students will emerge with a comprehensive perspective and a robust skill set in designing environmentally friendly, lightweight products and systems (such as lightweight design of mechanical structures). They will possess the expertise to assess the environmental impacts of products through Life Cycle Assessment, strategically minimizing lifecycle footprints. Furthermore, students will acquire an in-depth understanding of cutting-edge solutions in sustainable manufacturing, including digital machining and additive manufacturing, as well as de-/re-manufacturing processes such as disassembly and recycling. This knowledge enables them to contribute significantly to reducing the environmental footprint of products and materials.



CM4 Green Design and Sustainable Manufacturing

PRE-REQUISITES

The recommended prerequisites for the Green Design and Sustainable Manufacturing track encompass a foundation in design methods and manufacturing processes, technical drawing, fundamental statistics, and finite element analysis. A solid grasp of these areas ensures a strong starting point for students aspiring to enrol in this track.

MINORS

Within the second-year curriculum, students can explore various complementary courses and engage in dedicated laboratories across three specialized minors: Green Design, Sustainable Smart Manufacturing, and Additive Manufacturing. The Green Design minor tackles the design of products and systems, steering them towards environmentally and economically sustainable solutions. The courses within this path emphasize light design, reliability, bio-inspired solutions, and design methods that harness the advancements of Industry 4.0. Instead, the Sustainable Smart Manufacturing minor comprises courses specifically focused on digitalizing products, processes, systems, and factories, serving as a foundation for the principles of circular economy, sustainability, and innovative design methodologies. Finally, the Additive Manufacturing (AM) minor explores the extensive opportunities enabled by AM technologies for the digital+green (twin) transition to design and produce a new generation of products that are lightweight, energy-efficient, and more durable.



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JOB OPPORTUNITIES

The Green Design and Sustainable Manufacturing track equips students with valuable skills applicable to technical and production roles within industrial and manufacturing companies. Job opportunities often include positions in industrial digitalization, circular and sustainable economy, and digital and green transition realms.

PARTNER UNIVERSITIES

The Green Design and Sustainable Manufacturing track has established connections with prominent European and international academic institutions, facilitating opportunities for students to conduct thesis works in collaboration with partner companies (e.g. Baker Hughes, GE Additive, GE AVIO, JOBS, Leonardo, Mandelli, MCM, R.F. Celada, Scuderia Ferrari, Siemens Digital EXperience Center DEX) and universities among which École Nationale Supérieure des Mines de Paris (Mines Paris – PSL, France), Karlsruher Institut für Technologie (KIT, Germany), Technische Universität München (TUM, Germany), Trinity College Dublin (Ireland), Chalmers Tekniska Högskola (Chalmers, Sweden), Georgia Institute of Technology (Georgia Tech, USA), Massachusetts Institute of Technology (MIT, USA), and Northwestern University (NU, USA).



CM4 Green Design and Sustainable Manufacturing

1 YEAR COURSES 60 ECTS

40 ECTS

	ECTS
<u>Measurements for Mechanical Engineering</u>	5
<u>Dynamics of Mechanical Systems</u>	5
<u>Machine Design</u>	5
<u>Advanced Manufacturing Processes A</u>	10
<u>Design and Management of Production Systems</u>	10
<u>Advanced Materials for Mechanical Engineering</u>	5

20 ECTS

	ECTS
<u>Methods and Tools for Circular Mechanical Design</u>	10
<u>Manufacturing Systems Engineering II</u>	5
<u>De-manufacturing</u>	5

CM4 Green Design and Sustainable Manufacturing

2 YEAR COURSES

40 ECTS + 20 ECTS Master's Thesis

10 ECTS

ECTS

<u>Digital Machining A</u>	10
<u>Lightweight Design of Mechanical Structures</u>	10
<u>Additive Manufacturing A</u>	10
<u>Materials Engineering, Recycling and Environmental Impact A</u>	10

5 ECTS

ECTS

<u>LAB - Additive Manufacturing for the Green Transition</u>	5
<u>LAB - Digital Machining</u>	5
<u>LAB - Remanufacturing</u>	5
<u>LAB - Robotic Manufacturing</u>	5

5 ECTS

ECTS

<u>Open Course</u>	5
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CM4 Green Design and Sustainable Manufacturing

20 ECTS

	ECTS
<u>Energy Conversion Technologies</u>	5
<u>Vision Based 3D Measurements</u>	5
<u>Metamaterials and Metastructures</u>	5
<u>Industrial Robotics</u>	5
<u>Advanced Design of Machine Elements</u>	5
<u>Biomimetic Structure Design</u>	5
<u>Lightweight Design of Mechanical Structures - Fundamentals*</u>	5
<u>Non-Destructive Testing and Evaluation for Materials and Components</u>	5
<u>Reliable and Resilient Design of Mechanical Systems</u>	5
<u>Additive Manufacturing for Space and Aerospace Applications</u>	5
<u>Topology Optimisation</u>	5
<u>Intellectual Property and Patents in Innovation</u>	5
<u>Methods for Complex Shape Generation</u>	5

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	ECTS
<u>Product Digital Twin</u>	5
<u>Additive Manufacturing B*</u>	5
<u>Digital Factory</u>	5
<u>Digital Machining B*</u>	5
<u>Geometry Assurance</u>	5
<u>Quality Data Analysis B</u>	5
<u>Repairing and Re-manufacturing Processes</u>	5
<u>Circular Industrial Systems</u>	5
<u>Sustainable Manufacturing</u>	5
<u>Polymer Technologies for Circular Economy</u>	5
<u>Failure Analysis, Sicurezza Industriale e Ingegneria Forense</u>	5
<u>Materials and Simulation Tools for Sustainable Processes</u>	5
<u>Materials Engineering, Recycling and Environmental Impact B*</u>	5

*Selectable if not selected before.

CM4 Green Design and Sustainable Manufacturing

MINOR: GREEN DESIGN

	ECTS
<u>Energy Conversion Technologies</u>	5
<u>Industrial Robotics</u>	5
<u>Advanced Design of Machine Elements</u>	5
<u>Biomimetic Structure Design</u>	5
<u>Additive Manufacturing B*</u>	5
<u>Digital Machining B*</u>	5
<u>Lightweight Design of Mechanical Structures - Fundamentals*</u>	5
<u>Non-Destructive Testing and Evaluation for Materials and Components</u>	5
<u>Reliable and Resilient Design of Mechanical Systems</u>	5
<u>Repairing and Remanufacturing</u>	5
<u>Failure Analysis, Sicurezza Industriale e Ingegneria Forense</u>	5
<u>Intellectual Property and Patents in Innovation</u>	5

CM4 Green Design and Sustainable Manufacturing

MINOR: SUSTAINABLE SMART MANUFACTURING

	ECTS
<u>Energy Conversion Technologies</u>	5
<u>Vision Based 3D Measurements</u>	5
<u>Industrial Robotics</u>	5
<u>Product Digital Twin</u>	5
<u>Digital Factory</u>	5
<u>Digital Machining B*</u>	5
<u>Circular Industrial Systems</u>	5
<u>Lightweight Design of Mechanical Structures - Fundamentals*</u>	5
<u>Materials Engineering, Recycling and Environmental Impact B*</u>	5
<u>Polymer Technologies for Circular Economy</u>	5
<u>Intellectual Property and Patents in Innovation</u>	5

CM4 Green Design and Sustainable Manufacturing

MINOR: ADDITIVE MANUFACTURING

	ECTS
<u>Energy Conversion Technologies</u>	5
<u>Metamaterials and Metastructures</u>	5
<u>Topology Optimisation</u>	5
<u>Methods for Complex Shape Generation</u>	5
<u>Additive Manufacturing B*</u>	5
<u>Geometry Assurance</u>	5
<u>Quality Data Analysis B</u>	5
<u>Repairing and Remanufacturing</u>	5
<u>Sustainable Manufacturing</u>	5
<u>Additive Manufacturing for Space and Aerospace Applications</u>	5
<u>Materials and Simulation Tools for Sustainable Processes</u>	5
<u>Intellectual Property and Patents in Innovation</u>	5