

CM4 Sustainable Manufacturing Engineering

LEARNING OBJECTIVES

The distinctive value of CM4 lies in its ability to seamlessly integrate product design and manufacturing, with the primary goal of achieving technical and economic optimization while simultaneously enhancing environmental sustainability. The courses of the first year are grounding courses including fundamental engineering knowledge for designing products, manufacturing them and managing their production by considering the circular economy paradigm. The courses of the second year cover three minors to better focus on Green Design or Smart Sustainable Manufacturing or Additive Manufacturing.

LEARNING OUTCOMES

Upon successfully completing the Sustainable Manufacturing Engineering 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 Sustainable Manufacturing Engineering

PRE-REQUISITES

The recommended prerequisites for the Sustainable Manufacturing Engineering 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, Smart Sustainable 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 Smart Sustainable 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 Sustainable Manufacturing Engineering 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. Possible roles are Manufacturing Engineer, Design Engineer (Mechanical Focus), Additive Manufacturing Engineer, Process Engineer, Quality Engineer, Environmental Engineer (Manufacturing), IoT Engineer (Manufacturing).

PARTNER UNIVERSITIES

The Sustainable Manufacturing Engineering 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 Sustainable Manufacturing Engineering

1 YEAR COURSES 60 ECTS

40 ECTS

ECTS

Measurements for Mechanical Engineering	5
Dynamics of Mechanical Systems	5
Machine Design	5
Advanced Manufacturing Processes A	10
Design and Management of Production Systems	10
Advanced Materials for Mechanical Engineering	5

20 ECTS

ECTS

Methods for Sustainable Mechanical Design	10
Manufacturing Systems Engineering II	5
De-manufacturing	5

CM4 Sustainable Manufacturing Engineering

2 YEAR COURSES

40 ECTS + 20 ECTS Master's Thesis

10 ECTS

ECTS

Digital Machining A	10
Lightweight Design of Mechanical Structures	10
Additive Manufacturing A	10
Production and Environmental Impact in Materials Engineering and Steelmaking A	10

5 ECTS

ECTS

LAB - Additive Manufacturing for the Green Transition	5
LAB - Digital Machining	5
LAB - Remanufacturing	5
LAB - Robotic Manufacturing	5

5 ECTS

ECTS

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CM4 Sustainable Manufacturing Engineering

20 ECTS

ECTS

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

CM4 Sustainable Manufacturing Engineering

ECTS

Product Digital Twin	5
Additive Manufacturing B*	5
Digital Factory	5
Digital Machining B*	5
Geometry Assurance	5
Quality Data Analysis B	5
Repairing and Remanufacturing	5
Circular Industrial Systems	5
Sustainable Manufacturing	5
Polymer Technologies for Circular Economy	5
Failure Analysis, Sicurezza Industriale e Ingegneria Forense	5
Materials and Simulation Tools for Sustainable Processes	5
Production and Environmental Impact in Materials Engineering and Steelmaking B*	5

*Selectable if not selected before.

CM4 Sustainable Manufacturing Engineering

MINOR: GREEN DESIGN

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

CM4 Sustainable Manufacturing Engineering

MINOR: SMART SUSTAINABLE MANUFACTURING

	ECTS
Energy Conversion Technologies	5
Vision Based 3D Measurements	5
Industrial Robotics	5
Product Digital Twin	5
Digital Factory	5
Digital Machining B*	5
Circular Industrial Systems	5
Lightweight Design of Mechanical Structures - Fundamentals*	5
Production and Environmental Impact in Materials Engineering and Steelmaking B*	5
Polymer Technologies for Circular Economy	5
Intellectual Property and Patents in Innovation	5
Cyber-Physical Manufacturing Systems	5

CM4 Sustainable Manufacturing Engineering

MINOR: ADDITIVE MANUFACTURING

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