POLITECNICO MILANO 1863

MSc Degree Program in Automation and Control Engineering

Thematic Areas and Training Profiles

Academic Year 2026-2027

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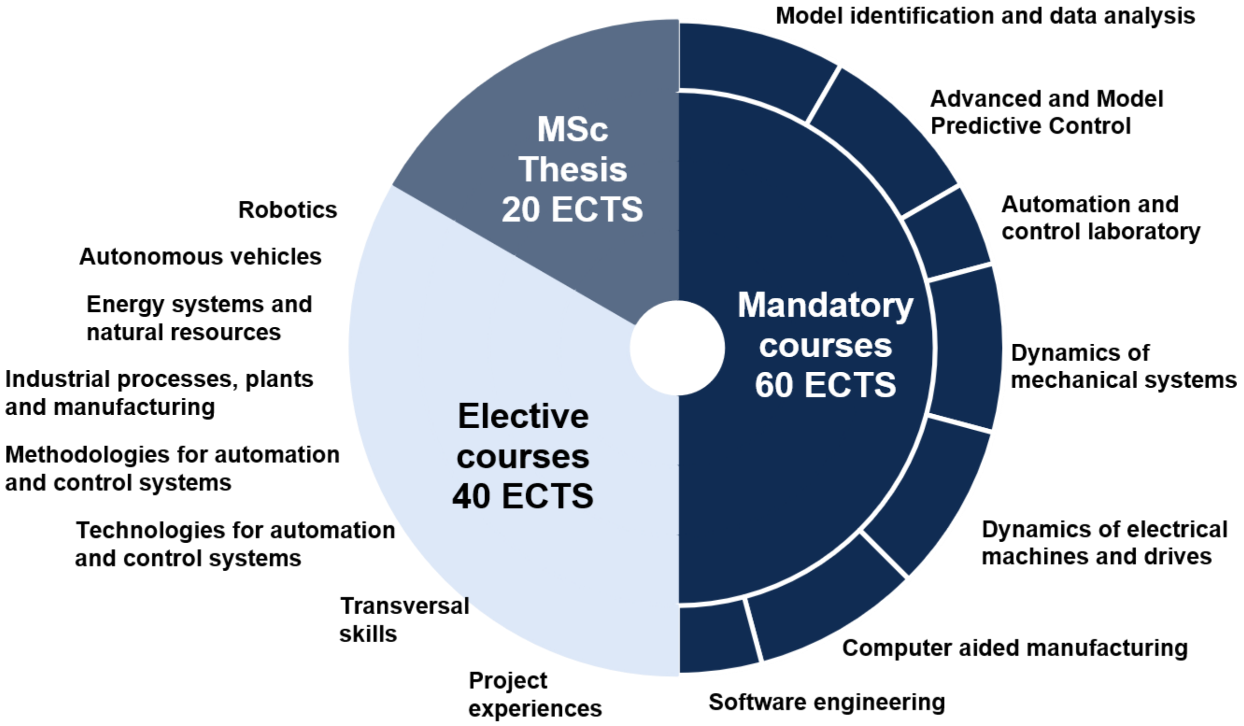
Contents

1. Foreword

This document presents the organization of the offering of **elective courses** of the MSc Degree Program in Automation and Control Engineering (ATM) into the following **thematic areas**:

- **Methodologies for automation and control systems**
- **Technologies for automation and control systems**
- **Robotics**
- **Autonomous vehicles**
- **Energy systems and natural resources**
- **Industrial processes, plants and manufacturing**
- **Project experiences**
- **Transversal skills**

Electives account for a significant part of the training program, as summarized by the following figure:



Each thematic area is accompanied by an overview of the included topics and a table of courses, with the indication of their location within the official tables of elective courses of the Degree Program. The latter are included for completeness in the Appendix, together with the rules for study plan composition.

Moreover, this document provides suggestions for possible **training profiles**, which the students can use as references when assembling their study plan.

This document will be updated on a yearly basis.

Why “thematic areas” and not “tracks”?
A “**track**” is a collection of courses that students **must** take if they decide to enroll in it. It provides a “top-down” selection of courses that are chosen by the faculty Board to build a training profile around the track’s topic.

On the other hand, a “**thematic area**” is a set of courses pertaining to a topic, to be considered as suggestions for students that have an interest in that topic. Thematic areas leave the students free to design their study plan in a “bottom-up” approach, at the same time providing them with a clear orientation tool.

The mandatory courses of the Automation and Control Engineering Degree Program (60 ECTS) prepare all students to be highly skilled professionals capable of taking on any challenge pertaining to modeling, analysis and design of complex automation and physical AI systems, where data-driven algorithms interact with physical processes under constraints such as safety, robustness, and real-time operation.

Given the high interdisciplinary nature of automation, the faculty Board decided that it is more appropriate to let the students choose freely the remaining 40 ECTS of elective courses and 20 ECTS of final exam (MSc thesis), without imposing top-down tracks, but rather organizing the offering into thematic areas.

Advantages for the students:
- They have a clear orientation tool for the elective offering;
- They can more easily spot the courses that fall in their interest;
- They still have simple rules for study plan composition (recalled in the Appendix);
- They can still select their courses freely, without necessarily “completing” a single thematic area, compatibly with the training goals and rules of the Degree Program.

Advantages for the Faculty Board:
- It can better communicate the training project of the Degree Program and the course offering, both internally and externally;
- It can more easily plan and maintain the course offering according to an organized teaching Program, considering the scientific, technological and economic trends, the needs of industry and society, and the expertise and research focus of the Faculty.

2. Thematic areas

a. Methodologies for automation and control systems

CODE	FIELD	TITLE	ECTS	TAB	Sem
055512	IIND-02/A IIND-08/A IINF-04/A	ADVANCED TOPICS IN AUTOMATION AND CONTROL ENGINEERING	5	1 or 2	1 or 2
052354	IINF-04/A	DATA DRIVEN CONTROL SYSTEM DESIGN	5	1	1
052369	IINF-04/A	NETWORKED CONTROL	5	1	1
097469	IINF-04/A	NONLINEAR CONTROL	5	1	1
062047	IINF-04/A	NUMERICAL OPTIMIZATION FOR CONTROL	5	1	1
051197	IINF-04/A	ROBUST CONTROL	5	1	1
093060	IINF-04/A	SAFETY IN AUTOMATION SYSTEMS	5	1	1
094172	IINF-04/A	SYSTEMS THEORY (NONLINEAR DYNAMICS)	5	1	1
056808	IIND-02/A	VIBRATION CONTROL AND DIAGNOSTICS OF MECHANICAL SYSTEMS	5	1	1
089194	IINF-04/A	COMPLESSITÀ NEI SISTEMI E NELLE RETI	5	3	1
051823	MATH-06/A	DISCRETE OPTIMIZATION	5	4	2
056893	IINF-05/A	MULTIAGENT SYSTEMS	5	3	1
089180	MATH-05/A	NUMERICAL ANALYSIS	5	3	1
051822	MATH-06/A	NONLINEAR OPTIMIZATION	5	4	2

Notes:

- Courses in TAB1 and TAB2 in this thematic area have guaranteed timetable compatibility.

Overview

The thematic area *Methodologies for automation and control systems* encompasses the theoretical, mathematical, and computational foundations that underpin the analysis and design of modern automation systems. It represents the methodological core of the MSc Degree Program in Automation and Control Engineering, offering a particularly rich and articulated set of learning opportunities aimed at developing high-level, internationally competitive expertise in advanced automation and control methods.

In coherence with the bottom-up philosophy described in the foreword, this thematic area brings together courses that focus on fundamental principles and systematic approaches, rather than on specific application sectors. This breadth and depth of training enable students to build a solid, versatile skill set, capable of supporting innovation across a wide range of domains. The emphasis is on providing a rigorous framework for modeling complex dynamical systems, designing control and decision strategies, and assessing their performance in terms of efficiency, robustness, and reliability.

Through this comprehensive methodological preparation, students are equipped to become world-class experts in the analysis and control of complex systems, able to address the challenges of modern engineering applications. These competences are central to the development of advanced autonomous systems, next-generation industrial automation solutions, and emerging physical AI paradigms, where intelligent algorithms must interact with real-world processes under strict physical and operational constraints.

In this context, automation engineers are required not only to design intelligent and adaptive solutions, but also to guarantee stability, safety, and real-time operation—objectives that rely on strong control-theoretic and optimization foundations. The thematic area therefore plays a key role in shaping professionals capable of bridging theoretical rigor and practical impact in highly demanding and evolving technological scenarios.

The courses are regularly updated to reflect the latest advances in control theory, optimization, and data-driven methodologies, ensuring that the educational offer remains aligned with cutting-edge research and industrial innovation.

What will you study?

Within this thematic area, students are exposed to a broad and coherent set of advanced methodologies for the analysis, control, and optimization of dynamical systems. The courses address both classical and modern approaches, covering the full spectrum from model-based techniques to data-driven methods.

Students will deepen their understanding of nonlinear dynamical systems and advanced control design, learning how to deal with uncertainty, disturbances, and complex system behaviors. Alongside this, they acquire strong competencies in optimization and numerical methods, which play a central role in solving control and decision problems, especially in the presence of constraints and large-scale systems.

The study plan also includes approaches to control in networked and distributed settings, as well as methodologies for designing controllers directly from data. These aspects are increasingly important in interconnected and cyber-physical systems. Attention is also devoted to safety and reliability, with methods aimed at ensuring the correct and secure operation of automation systems, even in the presence of uncertainty and complexity. Finally, specialized courses allow students to explore applications of control methodologies to specific domains, such as mechanical systems, or to engage with emerging and interdisciplinary topics.

A detailed description of the contents, objectives, and learning outcomes of each course is available in the official pages of Politecnico di Milano.

What are the possible applications and opportunities after graduation?

The strong methodological background developed in this thematic area enables graduates to address complex engineering problems in a rigorous and systematic way, opening opportunities across a wide range of industrial and research domains.

In industry, graduates can take roles in the design and implementation of advanced control systems, working in sectors such as manufacturing, energy, automotive, and aerospace. Their expertise allows them to develop solutions that improve system performance, efficiency, and robustness, as well as to design optimization and decision-making algorithms for complex processes. The ability to build and analyze mathematical models also makes them well suited for activities related to simulation, digital twins, and model-based design.

At the same time, the increasing relevance of data and connectivity creates opportunities in emerging domains, where automation intersects with artificial intelligence. Graduates may contribute to the development of physical AI systems, combining data-driven techniques with control methodologies. In these contexts, engineers must address key challenges such as ensuring safety and reliability, managing uncertainty, and meeting real-time computational constraints.

The methodological skills acquired in this area also provide a solid foundation for research careers. Graduates may pursue PhD studies or research positions in control theory, systems engineering, optimization, or applied mathematics, contributing to innovation in fields such as autonomous systems, cyber-physical systems, and intelligent infrastructures.

More broadly, the impact of this area extends to several societal challenges, including sustainable energy management, safe and reliable automation, and the development of resilient and efficient industrial systems.

How does this thematic area connect with the other thematic areas?

The *Methodologies for automation and control systems* thematic area plays a transversal role within the Degree Program, providing foundational tools that are essential for all other areas.

Its connection with *Technologies for automation and control systems* lies in the fact that the theoretical methods developed here are ultimately implemented through hardware and software platforms. In *Robotics* and *Autonomous vehicles*, advanced control, estimation, and optimization techniques are central to enabling autonomy, interaction, and safe operation. In *Energy systems and natural resources*, these methodologies support efficient management, optimization, and integration of complex infrastructures such as smart grids.

Similarly, in *Industrial processes, plants and manufacturing*, they underpin process control, diagnostics, and optimization, contributing to improved performance and flexibility. The link with *Project experiences* is particularly important, as it allows students to apply abstract methodologies to real-world problems, bridging the gap between theory and practice. Finally, the analytical rigor and problem-solving mindset developed in this area strongly support the acquisition of *Transversal skills*, which are essential for tackling complex and interdisciplinary engineering challenges.

b. Technologies for automation and control systems

CODE	FIELD	TITLE	ECTS	TAB	Sem
055513	IMIS-01/A IMIS-01/B	ADVANCED MEASUREMENT SYSTEMS FOR CONTROL APPLICATIONS	5	2	2
095901	IINF-04/A	ICT FOR CONTROL SYSTEMS ENGINEERING	5	1	1
097484	IINF-04/A	SIMULATION TECHNIQUES AND TOOLS	5	2	2
054654	IINF-01/A	ELECTRONIC SYSTEMS	10	3	1
063501	IINF-05/A	FORMAL METHODS FOR SOFTWARE ENGINEERING (UIC 540)	5	4	2
099993	IINF-05/A	IMAGE ANALYSIS AND COMPUTER VISION	5	3	1
054323	IINF-03/A	INTERNET OF THINGS	5	4	2
097485	IIND-03/A	MACHINE DESIGN	5	4	2
094179	IMIS-01/B	OPTICAL MEASUREMENTS	5	3	1
090918	IINF-01/A	POWER ELECTRONICS	10	3	1

Notes:

- Courses in TAB1 and TAB2 in this thematic area have guaranteed timetable compatibility.

Overview

The thematic area *Technologies for automation and control systems* focuses on the hardware, software, and enabling infrastructures that support the implementation of modern automation and control solutions. While methodological courses provide the theoretical foundations, this area addresses the concrete technological means through which control systems are realized, integrated, and deployed in real-world applications.

In line with the structure of the Degree Program, this thematic area collects courses that cover sensing, computation, communication, and actuation technologies, offering students a comprehensive perspective on the technological stack underlying automation systems. Attention is devoted to the interaction between physical components and digital platforms, which is a defining characteristic of contemporary cyber-physical systems.

This area is especially relevant in the context of increasingly interconnected and intelligent systems, where automation relies on advanced sensing, embedded electronics, communication networks, and computational tools. These technologies form the backbone of modern applications, including industrial automation, smart infrastructures, and physical AI systems.

What will you study?

Within this thematic area, students explore the key technologies that enable the implementation and operation of automation and control systems, gaining both theoretical understanding and practical insight into their functioning and integration.

The study plan includes technologies for measurement and sensing, which are fundamental for acquiring accurate information from physical systems, as well as electronic and power systems, which provide the hardware infrastructure for signal processing, actuation, and energy conversion. Students also learn about information and communication technologies (ICT) for control, which are essential for connecting system components and enabling distributed and networked operation.

A significant part of the area is devoted to modeling and simulation tools, which support the design and validation of complex systems, and to formal methods, which provide rigorous approaches for verifying correctness in concurrent and real-time systems. In addition, students are introduced to computer vision and image analysis techniques, which enable perception capabilities, and to Internet of Things (IoT) technologies, which play a central role in building interconnected and data-rich environments.

A detailed description of each course, including contents and learning objectives, is available in the official pages of Politecnico di Milano.

What are the possible applications and opportunities after graduation?

The competencies developed in this thematic area prepare graduates to design, implement, and integrate the technological components of automation systems, enabling them to operate in a variety of industrial and high-tech sectors.

Graduates can work on the development of measurement and sensing systems, contributing to applications where accurate data acquisition is critical, such as industrial automation, healthcare technologies, and environmental monitoring. Their knowledge of electronics and power systems enables them to design and manage embedded and energy-efficient systems, which are essential in sectors such as automotive, aerospace, and energy.

The expertise in ICT, IoT, and communication technologies opens opportunities in the design of connected and distributed systems, including smart factories, smart cities, and digital infrastructures. Similarly, skills in simulation and formal methods are highly valued in activities related to system validation, testing, and verification, particularly in safety-critical applications.

The inclusion of computer vision and perception technologies allows graduates to contribute to systems requiring advanced sensing and interpretation of the environment, including robotics, autonomous systems, and intelligent monitoring platforms. In the broader context of physical AI systems, these technological competencies are essential to enable the interaction between algorithms and the physical world, particularly in terms of sensing, computation, and actuation capabilities.

How does this thematic area connect with the other thematic areas?

The *Technologies for automation and control systems* area is tightly interconnected with the other thematic areas of the Degree Program, as it provides the practical means to implement the concepts developed elsewhere.

It naturally complements the *Methodologies for automation and control systems* area, translating theoretical models and algorithms into concrete implementations. In *Robotics* and *Autonomous vehicles*, it provides the sensing, computing, and communication technologies required for perception, control, and interaction with the environment. In *Energy systems and natural resources*, it supports the deployment of monitoring and control infrastructures, such as smart grids and energy management systems.

In the context of *Industrial processes, plants and manufacturing*, these technologies enable automation, digitalization, and integration of production systems, contributing to Industry 4.0 paradigms. The connection with *Project experiences* is particularly strong, as students can apply and integrate different technologies in realistic scenarios. Finally, the area contributes to the development of *Transversal skills*, particularly in system integration, technology selection, and multidisciplinary engineering design.

c. Robotics

CODE	FIELD	TITLE	ECTS	TAB	Sem
064326	IINF-04/A	AERIAL ROBOTICS	5	2	2
064493	IINF-04/A	COLLABORATIVE, INTELLIGENT AND HUMANOID ROBOTICS	5	1	1
064839	IINF-04/A	CONTROL OF MOBILE ROBOTS	5	1	1
064327	IINF-04/A	CONTROL OF ROBOTIC MANIPULATORS	5	2	2
064492	IBIO-01/A	MEDICAL ROBOTICS	5	1	1
064328	IINF-04/A	ROBOTICS LABORATORY	5	1	1
052359	IINF-05/A	PERCEPTION, LOCALIZATION AND MAPPING FOR MOBILE ROBOTS	5	4	2

Notes:

- Courses in TAB1 and TAB2 in this thematic area have guaranteed timetable compatibility.
- The course 064327 CONTROL OF ROBOTIC MANIPULATORS, listed in Table 2 at the 2° semester of the 1° year, is a prerequisite for courses 064328 ROBOTICS LABORATORY, 064992 MEDICAL ROBOTICS, and 064493 COLLABORATIVE, INTELLIGENT AND HUMANOID ROBOTICS, listed in TAB 1 at the 1° semester of the 2° year.
- The course 064328 - ROBOTICS LABORATORY can be inserted in the Study Plan after a selection procedure carried out by the Study Course. If you participate in the procedure, do not submit the Study Plan before the publication of the results, but save it as a draft.

Overview

The thematic area *Robotics* focuses on the design, control, and intelligent behavior of systems capable of interacting with the physical world. It represents one of the most dynamic and interdisciplinary areas within Automation and Control Engineering, combining concepts from control theory, perception, artificial intelligence, and system integration.

Within the MSc Degree Program, this thematic area is organized around two main domains: robotic manipulators and mobile robotics systems. Robotic manipulators, typically operating in structured environments, are central to industrial and medical applications, while mobile robots are designed to navigate autonomously in dynamic and unstructured environments.

A key element of this area is the foundational role of control. In particular, the course Control of Robotic Manipulators provides the essential background for modeling and controlling articulated systems and is considered propaedeutic to all other courses involving manipulators, including collaborative, intelligent and humanoid robotics, medical robotics, and the robotics laboratory.

The course offering in robotics is particularly broad, reflecting current technological trends and the growing demand for robotics expertise in industry and research. The richness of the available courses allows students to build a highly coherent and specialized study plan. In fact, by appropriately selecting elective courses, a student can devote almost up to the entirety of the 40 available ECTS to this thematic area, effectively shaping a study profile that is comparable to a dedicated MSc Degree in Robotics.

What will you study?

Within this thematic area, students explore the fundamental and advanced aspects of robotic systems, developing competencies that range from low-level control to high-level autonomy and interaction.

The study of robotic manipulators is centered on the course *Control of Robotic Manipulators*, which introduces modeling, kinematics, dynamics, and control of articulated mechanical systems. This course provides the theoretical basis required to address more advanced topics, such as interaction with humans and operation in complex environments. Building on these foundations, *Collaborative, Intelligent and Humanoid Robotics* addresses systems designed to safely and effectively interact with humans, while *Medical Robotics* focuses on high-precision applications in surgical and clinical domains, where reliability and safety are crucial.

In parallel, the thematic area addresses mobile robotics, where the emphasis is on autonomy and operation in real-world environments. *Control of Mobile Robots* introduces control strategies for systems capable of navigation, while *Perception, Localization and Mapping for Mobile Robots* focuses on equipping robots with the ability to perceive and interpret their surroundings. *Aerial Robotics* extends these concepts to unmanned aerial vehicles, highlighting challenges related to sensing, dynamics, and operation in three-dimensional and often uncertain environments.

The *Robotics Laboratory* plays a central integrative role, providing hands-on experience with real robotic platforms. It allows students to implement and validate control, perception, and planning algorithms, bridging the gap between theoretical knowledge and practical deployment.

A detailed description of each course, including contents and learning objectives, is available in the official pages of Politecnico di Milano.

What are the possible applications and opportunities after graduation?

The robotics thematic area provides access to a wide range of opportunities in both established industrial sectors and rapidly evolving technological domains.

In industrial settings, graduates can work on the design, control, and integration of robotic manipulators for manufacturing, assembly, and inspection processes. The increasing diffusion of collaborative robotics is creating new roles in environments where robots operate alongside humans, requiring advanced capabilities in safety, interaction, and adaptability.

At the same time, the competencies developed in mobile robotics enable graduates to contribute to applications involving autonomous systems operating in unstructured environments, such as logistics, service robotics, inspection, and exploration. Aerial robotics is gaining relevance in applications such as environmental monitoring, infrastructure inspection, and surveillance.

Important opportunities are also present in the field of medical and healthcare robotics, where robotic systems are used to support surgical procedures, rehabilitation, and assistive technologies. These applications demand high levels of precision, robustness, and safety, as well as the ability to operate in close interaction with human users.

More broadly, robotics plays a central role in the development of physical AI systems, where intelligent algorithms are embodied in machines that perceive and act in the real world. In this context, graduates are well prepared to tackle challenges related to autonomy, perception, and decision-making under uncertainty.

The comprehensive and in-depth preparation offered by this thematic area also provides an excellent foundation for research careers, including PhD studies and positions in advanced research and development environments.

How does this thematic area connect with the other thematic areas?

The Robotics thematic area is deeply interconnected with the other areas of the Degree Program, reflecting the inherently multidisciplinary nature of robotic systems.

It builds directly on the foundations provided by *Methodologies for automation and control systems*, as advanced control, estimation, and optimization techniques are essential for robotic motion and decision-making. At the same time, it relies on *Technologies for automation and control systems* for sensing, computation, and communication infrastructures.

There is also a connection with *Autonomous vehicles*, particularly in topics such as perception, localization, and navigation, albeit applied to different types of robotic platforms. Links with *Industrial processes, plants and manufacturing* are evident in the use of robotic manipulators for automation and production.

Depending on the specific projects offered, the *project experiences* area may offer opportunities to apply and integrate the knowledge acquired in robotics in practical contexts, while the *transversal skills* developed in this area include system integration, problem solving, and the ability to address complex and interdisciplinary challenges.

d. Autonomous vehicles

CODE	FIELD	TITLE	ECTS	TAB	Sem
064326	IINF-04/A	AERIAL ROBOTICS	5	2	2
056807	IINF-04/A	AUTOMATION AND CONTROL IN AUTONOMOUS VEHICLES	5	1	1
056810	IINF-04/A	AUTOMATION AND CONTROL IN ELECTRIC AND HYBRID VEHICLES	5	2	2
064839	IINF-04/A	CONTROL OF MOBILE ROBOTS	5	1	1
052578	IIND-08/B	AUTOMAZIONE DEI SISTEMI ELETTRICI DI TRASPORTO	5	3	1
052359	IINF-05/A	PERCEPTION, LOCALIZATION AND MAPPING FOR MOBILE ROBOTS	5	4	2

Notes:

- Courses in TAB1 and TAB2 in this thematic area have guaranteed timetable compatibility.

Overview

The thematic area *Autonomous vehicles* focuses on the modeling, control, perception, and operation of systems capable of navigating and interacting with their environment with a high degree of autonomy. It represents a rapidly evolving field within automation and control engineering, driven by strong technological innovation and growing industrial interest in intelligent transportation systems.

This thematic area is centered on the integration of control algorithms, perception systems, and decision-making processes within complex, safety-critical platforms such as road vehicles, electric mobility systems, and transportation infrastructures. It reflects the evolution of control engineering towards systems that must operate in real-world, uncertain, and dynamic environments.

The course offering is aligned with key industrial trends, including the transition towards electrification, the development of advanced driver assistance systems, and the progressive deployment of autonomous driving technologies. At the same time, it maintains a strong foundation in control theory, ensuring that students develop a rigorous understanding of system behavior and performance.

The relevance and quality of this training area are also reflected in extracurricular and competitive activities. For example, students from Politecnico di Milano, largely from the Automation and Control Engineering program and guided by its faculty, have achieved significant results in the Autonomous Indy Challenge, an international competition focused on high-speed autonomous racing. These experiences highlight the strong connection between the educational content of this area and real-world, cutting-edge applications.

What will you study?

Within this thematic area, students develop a comprehensive understanding of the main components and challenges involved in the design and operation of autonomous vehicles across different domains, including ground, aerial, and transportation systems.

The course *Automation and Control in Autonomous Vehicles* provides a system-level view of control architectures and algorithms enabling vehicle autonomy, including trajectory tracking, motion planning, and integration of subsystems. This is complemented by *Automation and Control in Electric and Hybrid Vehicles*, which addresses energy management and control of electrified powertrains, reflecting the increasing importance of sustainable mobility.

The course *Automazione dei Sistemi Elettrici di Trasporto* extends the perspective to transportation infrastructures, focusing on the automation and control of electrified transport systems and their large-scale operation.

From the perspective of perception and interaction with the environment, *Perception, Localization and Mapping for Mobile Robots* provides the fundamental tools that allow vehicles to estimate their state and understand their surroundings, enabling safe navigation in complex environments. These competencies are complemented by *Control of Mobile Robots*, which introduces control strategies for systems operating under uncertainty and in dynamic conditions.

The inclusion of *Aerial Robotics* further broadens the scope of the thematic area to unmanned aerial vehicles, addressing the specific challenges of flight dynamics, guidance, navigation, and control in three-dimensional and highly dynamic environments. This course highlights the increasing relevance of drone-based applications, from inspection and monitoring to advanced autonomous operations.

Together, these courses cover the main building blocks of autonomous vehicles, integrating sensing, control, and system-level design across multiple platforms, with attention to real-world constraints such as uncertainty, safety, and performance.

A detailed description of each course, including contents and learning objectives, is available in the official pages of Politecnico di Milano.

What are the possible applications and opportunities after graduation?

This thematic area prepares graduates for a wide range of opportunities in the transportation and mobility sectors, which are undergoing a profound technological transformation.

Graduates can work in the automotive industry on the development of advanced control systems for driver assistance and autonomous driving functionalities, contributing to motion control, trajectory planning, and system integration. The growing importance of electrification also opens opportunities in the design and optimization of energy management systems for electric and hybrid vehicles.

At the infrastructure level, competencies in transportation automation enable contributions to the development and operation of intelligent and electrified mobility systems. The knowledge of perception, localization, and control is also transferable to other autonomous platforms, including logistics systems and emerging mobility services.

Autonomous vehicles represent a prominent example of physical AI systems, where intelligent decision-making must be tightly integrated with control and must satisfy strict requirements in terms of safety, reliability, and real-time performance. Graduates are therefore well prepared to contribute to the development and validation of such systems in industrial and research environments.

The area also provides a solid basis for research careers in intelligent transportation systems, autonomous systems, and mobility technologies, both in academia and in industrial R&D.

How does this thematic area connect with the other thematic areas?

The *Autonomous vehicles* thematic area is closely connected with several other areas of the Degree Program, reflecting the multidisciplinary nature of modern mobility systems.

It shares strong methodological foundations with the area of *Methodologies for automation and control systems*, particularly in control design, estimation, and optimization. It is also closely related to the *robotics* thematic area, especially in topics such as mobile systems, perception, localization, and navigation.

The connection with *Technologies for automation and control systems* is essential, as autonomous vehicles rely on sensing, computation, and communication infrastructures. Links with *Energy systems and natural resources* are particularly relevant in the context of electric mobility and energy-efficient transportation, while connections with industrial processes may arise in production, testing, and validation of vehicle systems.

Depending on the specific projects offered, the *Project experiences* area may allow students to apply these concepts in practical settings, while the *Transversal skills* developed include system integration, critical thinking, and the ability to manage complex and safety-critical systems.

e. Energy systems and natural resources

CODE	FIELD	TITLE	ECTS	TAB	Sem
097471	IINF-04/A	ADVANCED PROCESS CONTROL	5	2	2
090916	IINF-04/A	AUTOMATION OF ENERGY SYSTEMS	5	2	2
097470	IIND-08/A	POWER ELECTRONICS AND SUPPLIES	5	2	2
057504	IIET-01/A IINF-04/A	ADVANCED METHODS FOR THE OPTIMAL MANAGEMENT OF THE ELECTRICAL GRID	5	4	2
095896	IINF-04/A	NATURAL RESOURCES MANAGEMENT	10	4	2

Notes:

- Courses in TAB2 in this thematic area have guaranteed timetable compatibility.

Overview

The thematic area *Energy systems and natural resources* focuses on the modeling, control, and optimization of systems involved in the production, conversion, distribution, and use of energy, as well as in the management of natural resources. It addresses one of the most relevant and rapidly evolving sectors of modern engineering, driven by the global transition towards sustainability, decarbonization, and efficient resource utilization.

Within the MSc Degree Program, this thematic area emphasizes the role of automation and control methodologies in improving the efficiency, reliability, and flexibility of complex energy systems. These include electrical grids, energy conversion devices, and integrated energy infrastructures, which are increasingly characterized by high levels of variability, distributed generation, and strong interconnections.

The course offering reflects current technological and societal trends, such as the integration of renewable energy sources, the development of smart grids, and the need for advanced decision-making tools for resource management. At the same time, it maintains a solid grounding in process control and system optimization, ensuring that students are equipped with the skills required to address both traditional and emerging challenges in the energy domain.

This thematic area plays a key role in addressing global challenges such as decarbonization, energy security, and sustainable resource management.

What will you study?

Within this thematic area, students acquire a comprehensive understanding of the principles and methodologies required to control and optimize energy systems and manage natural resources effectively.

The course *Advanced Process Control* provides the foundations for controlling complex industrial and energy-related processes, addressing multivariable systems, constraints, and performance optimization. Building on this, *Automation of Energy Systems* focuses on the application of control techniques to energy infrastructures, with particular attention to their dynamic behavior and operational requirements.

A central role is played by optimization and decision-making methods, as highlighted in *Advanced Methods for the Optimal Management of the Electrical Grid*, where students learn how to manage large-scale energy networks, considering both technical and economic aspects. These topics are essential in the context of modern power systems, which must accommodate renewable energy sources and operate under uncertainty and variability.

The course *Power Electronics and Supplies* introduces the technologies that enable efficient energy conversion and control, which are fundamental for applications ranging from renewable generation to electrified transportation.

Finally, *Natural Resources Management* broadens the perspective beyond energy systems, addressing the sustainable use and management of natural resources. This course highlights the interdisciplinary nature of the field, connecting engineering solutions with environmental and societal considerations.

A detailed description of each course, including contents and learning objectives, is available in the official pages of Politecnico di Milano.

What are the possible applications and opportunities after graduation?

This thematic area prepares graduates to address some of the most pressing challenges related to energy and sustainability, offering opportunities in a wide range of industrial sectors and institutional contexts.

Graduates can work in the design, operation, and optimization of energy systems, including power generation plants, electrical grids, and energy management systems. The growing importance of renewable energy and distributed generation creates demand for engineers capable of integrating diverse energy sources and ensuring system stability and efficiency.

Opportunities are also present in industries related to power electronics and energy conversion, where control and optimization play a key role in improving system performance. In addition, graduates may contribute to the development of smart grids and intelligent energy infrastructures, which require advanced control, communication, and decision-making capabilities.

The inclusion of natural resources management opens further perspectives in sectors dealing with environmental sustainability, resource planning, and infrastructure management, where engineering solutions must be aligned with environmental and societal constraints.

More broadly, energy systems are an important domain of application for physical AI systems, where data-driven methods must be combined with control and optimization to manage complex, large-scale, and safety-critical infrastructures. In this context, graduates are well equipped to contribute to innovative solutions for sustainable development.

This area also provides a solid foundation for research careers in energy engineering, control systems, and sustainability, both in academia and in industrial research and development environments.

How does this thematic area connect with the other thematic areas?

The *Energy systems and natural resources* thematic area is strongly connected with several other areas of the Degree Program, reflecting the multidisciplinary nature of modern energy challenges.

It builds on *Methodologies for automation and control systems*, particularly in control design, system modeling, and optimization, which are essential for managing complex energy infrastructures. The connection with *Technologies for automation and control systems* is also significant, as energy systems rely on sensing, communication, and power conversion technologies.

There are natural links with *autonomous vehicles*, especially in relation to electric and hybrid mobility, where energy management and power electronics play a fundamental role. Connections with *Industrial processes, plants and manufacturing* arise in the control and optimization of energy-intensive processes and production systems.

Depending on the specific projects offered, the *Project experiences* area allows students to apply these concepts to real-world problems, while the *Transversal skills* include system-level thinking, sustainability awareness, and the ability to address large-scale and interdisciplinary challenges.

f. Industrial processes, plants and manufacturing

CODE	FIELD	TITLE	ECTS	TAB	Sem
097471	IINF-04/A	ADVANCED PROCESS CONTROL	5	2	2
064839	IINF-04/A	CONTROL OF MOBILE ROBOTS	5	1	1
064327	IINF-04/A	CONTROL OF ROBOTIC MANIPULATORS	5	1	1
090915	IINF-04/A	PRODUCTION SYSTEMS CONTROL	5	2	2
064328	IINF-04/A	ROBOTICS LABORATORY	5	1	1
097313	IIND-04/A	ADDITIVE MANUFACTURING	5	3	1
062148	IIND-04/A	DIGITAL TWIN OF PRODUCTION SYSTEMS B	5	3	1
096221	ICHI-01/C	DYNAMICS AND CONTROL OF CHEMICAL PROCESSES	5	4	2
062242	IIND-05/A	SMART MAINTENANCE AND INDUSTRIAL ASSET MANAGEMENT	10	3	1

Notes:

- Courses in TAB1 and TAB2 in this thematic area have guaranteed timetable compatibility.

Overview

The thematic area *Industrial processes, plants and manufacturing* focuses on the application of automation and control methodologies to industrial systems and production environments. It addresses the design, operation, and optimization of processes and plants, with the goal of improving efficiency, flexibility, quality, and sustainability in modern industry.

Within the MSc Degree Program, this area highlights the central role of control engineering in increasingly complex and interconnected industrial systems. It reflects the ongoing transformation of industry towards digitalization and smart manufacturing, where physical processes are tightly integrated with advanced computational tools, data analytics, and automation technologies.

The course offering combines well-established topics in process control with emerging trends such as digital twins, advanced manufacturing technologies, and smart maintenance. This provides students with broad and up-to-date preparation, aligned with industrial needs and technological evolution, and equips them to address both traditional and emerging challenges in production systems.

What will you study?

Within this thematic area, students develop a comprehensive understanding of the modeling, control, monitoring, and optimization of industrial processes and manufacturing systems.

A core component of the area is process control, addressed through courses such as *Advanced Process Control* and *Dynamics and Control of Chemical Processes*. These courses provide the tools to model and control complex industrial systems, dealing with multivariable dynamics, constraints, and uncertainty.

The control and coordination of production systems are explored in *Production Systems Control*, where students learn how to manage manufacturing operations efficiently. This is complemented by *Digital Twin of Production Systems B*, which introduces the use of digital models to monitor, simulate, and optimize industrial processes, representing a key aspect of modern smart manufacturing.

The thematic area also addresses system reliability and maintenance. *Smart Maintenance and Industrial Asset Management* focuses on advanced strategies for monitoring system health, predicting failures, and optimizing maintenance operations, emphasizing data-driven and predictive approaches that are increasingly central in industrial practice.

From the perspective of manufacturing technologies, *Additive Manufacturing* introduces innovative production techniques that enable new design approaches and flexible fabrication processes.

The integration of robotics within industrial environments is reflected in *Control of Robotic Manipulators* and *Control of Mobile Robots*, along with the *Robotics Laboratory*, which provides hands-on experience and an opportunity to apply control and perception techniques in realistic scenarios. These elements highlight the increasing role of flexible, connected, and intelligent automation in modern production systems.

A detailed description of each course, including contents and learning objectives, is available in the official pages of Politecnico di Milano.

What are the possible applications and opportunities after graduation?

This thematic area prepares graduates for a wide range of roles in industrial sectors, where automation and control are key drivers of innovation and competitiveness.

Graduates can work in the design and operation of control systems for industrial processes, including chemical plants, manufacturing systems, and complex production lines. Their competencies allow them to improve system performance, optimize resource usage, and ensure safe and reliable operation.

The increasing adoption of digital technologies in industry creates opportunities in areas such as smart manufacturing and Industry 4.0, where skills in digital twins, data-driven analysis, and system integration are highly valued. Graduates may also work in maintenance and diagnostics, using advanced monitoring techniques to detect anomalies, predict failures, and optimize maintenance strategies.

The integration of robotics in industrial environments opens further opportunities in the design of flexible and adaptive production systems, while knowledge of additive manufacturing provides access to innovative production processes and design methodologies.

More broadly, industrial systems are evolving towards increasingly complex and interconnected environments, often incorporating elements of physical AI systems, where control, data, and intelligent decision-making are combined. In this context, graduates are well prepared to contribute to the development of efficient, adaptive, and intelligent industrial solutions.

The area also offers a solid basis for careers in research and development, particularly in industrial automation, process control, and advanced manufacturing systems.

How does this thematic area connect with the other thematic areas?

The *Industrial processes, plants and manufacturing* thematic area is strongly connected with the other areas of the Degree Program, as it represents one of the main domains of application of automation and control engineering.

It builds on the foundations provided by *Methodologies for automation and control systems*, particularly in process modeling, control design, and optimization. It is also closely linked to *Technologies for automation and control systems*, which provide the sensing, actuation, and digital infrastructures required to implement automation in industrial environments.

There are strong connections with the *robotics* thematic area, especially in the use of robotic manipulators and mobile robots within production systems, and with *energy systems and natural resources*, particularly in the context of energy-intensive processes and efficient resource management.

Depending on the specific projects offered, the *project experiences* area provides opportunities to apply the acquired knowledge to real industrial problems, while the *transversal skills* include system integration, process understanding, and the ability to manage complex and interdisciplinary engineering systems.

g. Project experiences

CODE	FIELD	TITLE	ECTS	TAB	Sem
052353	IIND-02/A IIND-08/A IINF-04/A	PROJECT WORK	5	1 or 2	1 or 2
063591	IINF-01/A	SMART WEARABLES DESIGN AND PROTOTYPING	5	4	2
064288	IBIO-01/A IEGE-01/A IINF-04/A	TECHNOLOGY FOR HEALTH AND SOCIAL CHALLENGES	5	4	2

Notes:

- The course 052353 – PROJECT WORK can be inserted in the Study Plan after a selection procedure carried out by the Study Course. If you participate in the procedure, do not submit the Study Plan before the publication of the results, but save it as a draft.

Overview

The thematic area *Project experiences* focuses on hands-on, integrative activities that allow students to apply the knowledge and methodologies acquired during the MSc program to realistic and often interdisciplinary problems. It represents a fundamental complement to the more theoretical and methodological areas, providing an environment in which concepts are translated into practice.

Within the MSc Degree Program in Automation and Control Engineering, this area is designed to promote a learning-by-doing approach, where students actively engage in the design, development, and validation of complex systems. A distinctive feature of this thematic area is the strong interaction with industry, which allows students to work on real-world problems proposed by companies and to experience professional engineering workflows.

These activities expose students to open-ended challenges, requiring not only technical competencies but also the ability to work in teams, manage projects, and communicate results effectively. In this sense, the thematic area plays a key role in bridging academic training and professional practice, aligning well with both industrial needs and emerging technological trends.

What will you study?

Within this thematic area, students take part in project-based courses that emphasize the integration of knowledge across different domains of automation and control engineering, with a strong focus on practical implementation, teamwork, and real-world impact.

The course *Project Work* represents the core experience of this area. It is an elective course carried out in collaboration with industrial partners, where students work in teams on open innovation problems proposed by companies. The activity typically spans an entire semester and involves regular interaction with both academic and company mentors. Students organize their work in small groups and progressively develop solutions to real engineering challenges, undergoing periodic evaluations and concluding with a final report and presentation. This experience allows them to apply theoretical knowledge in a realistic context, while developing problem-solving, communication, and project management skills.

Smart Wearables Design and Prototyping provides a comprehensive hands-on experience in the design and development of wearable devices, covering the full prototyping chain. Students learn how to design electronic boards, develop embedded software for microcontrollers, integrate sensors, and realize physical structures through CAD tools and 3D printing. The course also introduces communication protocols and smartphone application development, enabling the creation of complete wearable systems. A significant portion of the course is devoted to laboratory activities, where students work in small teams to design and prototype a smart device - typically smart eyewear - starting from base templates and customizing elements such as sensing modules, firmware, physical design, and mobile applications. Through this process, students gain familiarity with low-power embedded systems, integration challenges, and design trade-offs, while working on case studies of industrial relevance.

Technology for Health and Social Challenges addresses real-world problems proposed by actors such as patient associations, foundations, and voluntary organizations. In this course, students work in small interdisciplinary teams to develop solutions that combine technical and managerial competencies. From a technical perspective, they may carry out feasibility studies or develop mock-ups and prototypes within a dedicated laboratory environment. From a managerial perspective, they learn how to define users' and patients' requirements, select appropriate business models in the healthcare domain, and perform health technology assessment to support decision-making. The course places strong emphasis on soft skills, including teamwork, project management, time management, and effective communication.

Overall, this thematic area emphasizes the ability to move from theoretical understanding to practical realization, working on complex and open-ended problems that require the integration of methodologies, technologies, and domain-specific knowledge.

A detailed description of each course, including contents and learning objectives, is available in the official pages of Politecnico di Milano.

Rules for project experiences in the study plan
Please note that, according to the rules for study plan composition (recalled in the Appendix and available in the official rules of the Degree Program), at most one course from the *project experiences* area can be included as effective by each student.

What are the possible applications and opportunities after graduation?

The competencies developed in this thematic area are highly valuable across a wide range of professional contexts, as they demonstrate the ability to apply theoretical knowledge to real-world problems in a structured and effective way.

Graduates gain direct experience in system design, prototyping, testing, and validation, which are essential skills in industrial environments. Exposure to real-world projects, often developed in collaboration with companies, facilitates the transition to professional roles and provides a better understanding of industrial workflows and expectations.

The experience in teamwork and interdisciplinary collaboration prepares graduates to operate in complex engineering environments, where different competencies must be integrated. In addition, the focus on application domains such as wearable technologies and health-related systems opens opportunities in emerging sectors that combine engineering with healthcare, human-centered design, and social innovation.

More broadly, the project-based nature of this thematic area strengthens problem-solving capabilities and adaptability, which are highly valued both in industry and in research. It also provides excellent preparation for the MSc thesis, where similar skills are required to address open-ended and complex problems.

How does this thematic area connect with the other thematic areas?

The *Project experiences* thematic area is inherently transversal. The projects provide a natural setting for applying the methodologies developed in the area of automation and control systems, as well as the technologies studied in sensing, computation, and system integration. Depending on the specific project, students may also engage with applications related to robotics, autonomous vehicles, energy systems, or industrial processes.

By integrating concepts from different areas, these experiences reinforce the coherence of the study plan and help students develop a system-level perspective. They also contribute significantly to the development of transversal skills, including teamwork, communication, project management, and the ability to address complex and interdisciplinary problems.

h. Transversal skills

CODE	FIELD	TITLE	ECTS	TAB	Sem
055514	IEGE-01/A	HIGH-TECH ENTREPRENEURSHIP	5	2	2
057072	IIND-05/A	AGILE PROJECT MANAGEMENT	5	T.S.	2
055806	PHIL-02/A	CRITICAL THINKING	5	T.S.	2
064834	GSPS-06/A IINF-04/A	DATA AND ALGORITHMIC FAIRNESS	5	T.S.	2
055807	GSPS-05/A	EMERGING TECHNOLOGIES AND SOCIETAL CHALLENGES	5	T.S.	2
056839	IMIS-01/B	ENGINEERING METHODS SUPPORTING JUSTICE	5	T.S.	2
052581	PHIL-02/A	ETHICS FOR TECHNOLOGY	5	T.S.	2
062747	M-FIL/03	ETHICS OF CLIMATE CHANGE	5	T.S.	2
063139	HIST-03/A	HISTORY OF TECHNOLOGICAL INNOVATION	5	T.S.	2
064254	IEGE-01/A	PATENTS AND INTELLECTUAL PROPERTY MANAGEMENT	5	T.S.	2
052585	IINF-05/A	PERSONALITÀ, TEAM BUILDING, LEADERSHIP	5	T.S.	2
056931	IIND-08/B PHIL-02/A	POWER SYSTEMS: ETHICAL ISSUES AND SOCIAL IMPLICATIONS	5	T.S.	1
063787	GIUR-01/A GIUR-04/A	TECHNICAL ACTIVITIES AND LEGAL IMPLICATIONS: LIABILITY, IP PROTECTION, AI REGULATION	5	T.S.	2
062747	PHIL-03/A	ETHICS OF CLIMATE CHANGE	5	T.S.	2

Overview

The thematic area *Transversal skills* complements the technical education of the MSc Degree Program in Automation and Control Engineering by providing students with a broader set of competencies that are essential for operating effectively in complex, multidisciplinary, and evolving professional environments.

While the core of the Degree Program focuses on methodologies and technologies for automation and control systems, this thematic area addresses the wider context in which engineering activities take place. It includes topics related to management, entrepreneurship, ethics, legal aspects, and societal impact, offering students the opportunity to develop a more comprehensive and responsible approach to engineering practice.

The courses in this area reflect the increasing importance of non-technical skills in modern engineering careers, where professionals are expected not only to design and implement solutions, but also to understand their implications, communicate effectively, and contribute to strategic and operational decision-making processes. This thematic area is therefore aligned with both industrial needs and broader societal challenges, supporting the formation of well-rounded engineers.

What will you study?

Within this thematic area, students explore a broad spectrum of topics that extend beyond traditional engineering content, focusing on skills and knowledge that support innovation, professional development, and responsible practice.

A first group of courses addresses management, organization, and personal development. *Agile Project Management* introduces modern approaches for managing complex and evolving engineering projects, while *Personalità, Team Building, Leadership* focuses on interpersonal dynamics, teamwork, and leadership development. These courses help students understand how to operate effectively within organizations and multidisciplinary teams.

Innovation and entrepreneurship are explored through *High-Tech Entrepreneurship* and *Patents and Intellectual Property Management*, which provide insight into how technological ideas are transformed into products and services, and how intellectual property can be protected and managed in competitive environments.

A significant part of the offering is devoted to ethical, legal, and societal aspects of technology. Courses such as *Ethics for Technology, Ethics of Climate Change*, *Engineering Methods Supporting Justice*, and *Power Systems: Ethical Issues and Social Implications* foster awareness of the responsibilities associated with engineering decisions and their impact on society and the environment. *Data and Algorithmic Fairness* addresses issues related to bias, transparency, and accountability in data-driven systems, which are increasingly central in modern automated systems. The course *Technical Activities and Legal Implications: Liability, IP Protection, AI Regulation* introduces key legal frameworks governing engineering practice, including emerging regulations related to artificial intelligence.

Students can also engage with broader perspectives on innovation and society through *Emerging Technologies and Societal Challenges* and *History of Industrial Technological Innovation*, which provide context on the evolution of technologies and their interaction with societal needs.

Finally, *Critical Thinking* supports the ability to analyze complex problems, evaluate alternative solutions, and make informed and well-justified decisions -skills that are essential across all areas of engineering.

A detailed description of each course, including contents and learning objectives, is available in [the official pages of Politecnico di Milano].

Rules for transversal skills and freely chosen courses (out of the Degree Program) in the study plan

Please note that, according to the rules for study plan composition (recalled in the Appendix and available in the official rules of the Degree Program), at most 10 ECTS from the Table "TRANSVERSAL SKILLS" can be included. These 10 ECTS are also shared with possible courses that are freely chosen by the students among the whole offering of Politecnico di Milano, subject to approval by the Study Plans Committee.

What are the possible applications and opportunities after graduation?

The competencies developed in this thematic area are applicable across all professional roles, enhancing the effectiveness and versatility of graduates in both industrial and research environments.

Graduates benefit from improved skills in project management, teamwork, and communication, which are essential for working in multidisciplinary teams and managing complex engineering projects. The exposure to entrepreneurship and innovation processes enables them to contribute to the development of new products and services, or to engage in entrepreneurial initiatives.

The knowledge of ethical and legal aspects supports responsible engineering practice, allowing graduates to address issues related to safety, sustainability, and societal impact, as well as to navigate regulatory frameworks and intellectual property considerations. These competencies are increasingly important in areas such as physical AI systems, where technological innovation must be aligned with ethical principles and regulatory requirements.

More broadly, transversal skills enhance adaptability and critical thinking, enabling graduates to operate effectively in rapidly evolving technological and organizational contexts, and to take on leadership roles over the course of their careers.

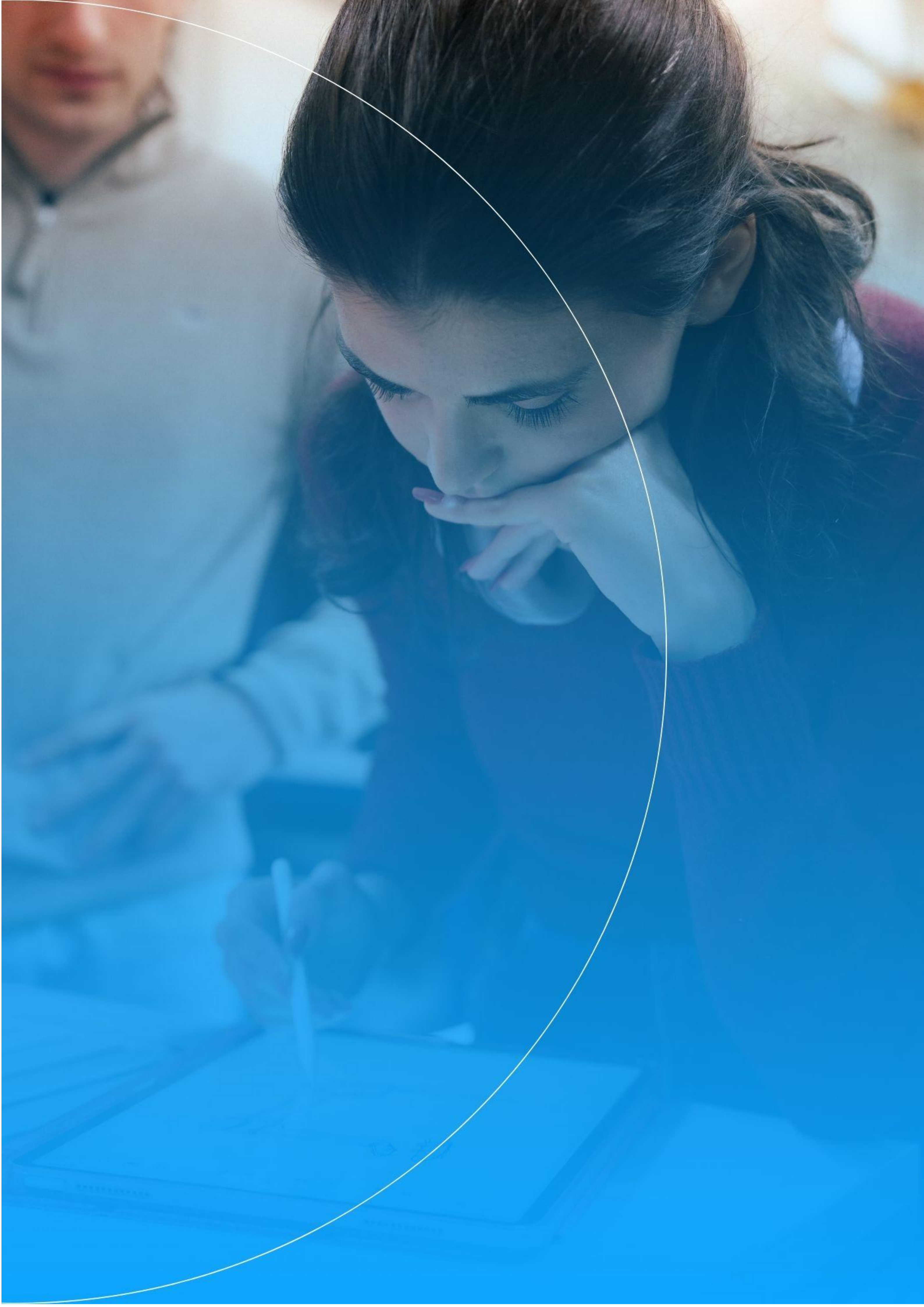
How does this thematic area connect with the other thematic areas?

The Transversal skills thematic area is inherently connected to all other areas of the Degree Program, as it provides competencies that complement and enhance technical expertise.

It supports the application of methodologies and technologies by providing tools for project management, decision-making, and communication. In areas such as robotics, autonomous vehicles, energy systems, and industrial processes, these skills are essential for managing complexity, coordinating teams, and ensuring that solutions are aligned with broader objectives.

The connection with project experiences is particularly strong, as transversal skills are directly applied in teamwork, project development, and interaction with stakeholders. At the same time, the ethical and societal perspectives offered in this area help contextualize technological solutions, ensuring that they are designed and implemented in a responsible and inclusive manner.

Overall, this thematic area contributes to the formation of engineers who are not only technically competent, but also capable of understanding and addressing the broader implications of their work.



3. Training Profiles

The following training profiles are provided as examples to guide students in the construction of their study plan. They are not mandatory tracks, but rather suggestions that illustrate coherent combinations of courses aligned with different educational goals and professional orientations.

Students are free to adapt these profiles according to their interests, while ensuring compliance with the rules for study plan composition and with the overall objectives of the MSc Degree Program in Automation and Control Engineering.

a. Application expert in "chosen thematic area"

This training profile is intended for students who wish to develop in-depth expertise in a specific application domain of automation and control engineering, such as *Robotics*, *Autonomous vehicles*, *Energy systems and natural resources*, or *Industrial processes, plants and manufacturing*.

The study plan is centered on a selected thematic area, where students can concentrate a significant portion of their elective credits to build a strong and coherent application-oriented background. This specialization is complemented by courses in methodologies or technologies for automation and control systems, which provide the necessary theoretical and technical foundations to support advanced applications.

Students may also include a project experience to strengthen practical competencies and gain exposure to real-world problems, as well as courses in transversal skills to develop complementary abilities in areas such as management, communication, and ethics.

This profile prepares graduates for roles requiring strong domain-specific expertise, such as robotics engineer, energy systems engineer, automation specialist in industrial environments, or developer of autonomous systems, as well as for research activities focused on specific application domains.

Courses	**ECTS**	**TAB**
Courses from a chosen thematic area among *Robotics*, *Autonomous vehicles*, *Energy systems and natural resources*, *Industrial processes, plants and manufacturing*	15 to 30	1 to 4
Courses in thematic areas *Methodologies for automation and control systems* or *Technologies for automation and control systems*	10 to 25	1 to 4
Course in area *Project experiences*	0 to 5	1,2, 4
Courses in area *Transversal skills*	0 to 10	2, T.S.

Satisfying minimum 20ECTS from TAB1 or 2, maximum 10ECTS from TAB T.S., see the Appendix

b. Expert of automation and control methods

This training profile is designed for students who aim to acquire a strong and in-depth background in the theoretical and methodological aspects of automation and control engineering.

The study plan is primarily built around courses in the thematic area *Methodologies for automation and control systems*, allowing students to explore advanced topics such as nonlinear control, robust control, optimization, and data-driven approaches. These courses provide a solid foundation for understanding and designing complex dynamical systems in a rigorous and systematic way.

To complement this methodological core, students select courses from application-oriented thematic areas or from the technologies area, enabling them to apply theoretical tools to concrete systems and domains.

A project experience can further strengthen the ability to implement and validate control strategies in practice, while transversal skills support analytical thinking and problem formulation.

This profile is particularly suited for students interested in research and innovation, advanced R&D roles, or positions that require strong analytical and modeling capabilities, including PhD programs in control systems, automation, or related disciplines.

Courses	**ECTS**	**TAB**
Courses in area *Methodologies for automation and control systems*	15 to 30	1 to 4
Courses from thematic areas *Robotics*, *Autonomous vehicles*, *Energy systems and natural resources*, *Industrial processes, plants and manufacturing*, *Technologies for automation and control systems*	10 to 25	1 to 4
Course in area *Project experiences*	0 to 5	1,2, 4
Courses in area *Transversal skills*	0 to 10	2, T.S.

Satisfying minimum 20ECTS from TAB1 or 2, maximum 10ECTS from TAB T.S., see the Appendix

c. Expert of automation and control technologies

This training profile targets students who wish to specialize in the technological aspects of automation and control systems, focusing on the hardware and software infrastructures that enable system implementation and integration.

The study plan emphasizes courses in the thematic area *Technologies for automation and control systems*, covering topics such as sensing, embedded systems, communication networks, simulation tools, and system integration. These competencies are essential for translating theoretical models and control algorithms into real-world applications.

Students complement this technological foundation with courses from methodological or application-oriented thematic areas, allowing them to understand how technologies are used in different domains, such as robotics, autonomous vehicles, energy systems, or industrial processes.

Project experiences can provide hands-on exposure to system development and integration, while transversal skills contribute to competencies in project management, innovation, and interdisciplinary collaboration.

This profile prepares graduates for roles focused on system implementation, integration, and deployment, such as automation engineer, systems engineer, embedded systems developer, or specialist in digital and connected infrastructures, as well as for technical roles in industrial R&D.

Courses	**ECTS**	**TAB**
Courses in area *Technologies for automation and control systems*	15 to 30	1 to 4
Courses from thematic areas *Robotics*, *Autonomous vehicles*, *Energy systems and natural resources*, *Industrial processes, plants and manufacturing*, *Methodologies for automation and control systems*	10 to 25	1 to 4
Course in area *Project experiences*	0 to 5	1,2, 4
Courses in area *Transversal skills*	0 to 10	2, T.S.

Satisfying minimum 20ECTS from TAB1 or 2, maximum 10ECTS from TAB T.S., see the Appendix

Contacts

Do you have further questions about the elective course offer of the MSc Degree Program in Automation and Control Engineering? You can contact:

For general information:
Chair of the Degree Program ingauto-deib@polimi.it

For study plans:
Information material on WeBeep
Study plans Committee pianidistudioauto-deib@polimi.it

For admissions:
Information material and F.A.Q. on the website https://www.ccsatm.polimi.it/
Admissions Committee ammissioniaouto-deib@polimi.it

Appendix: Tables of elective courses and rules for study plan composition

The offering of elective courses is formally organized in tables TAB1, TAB2, TAB3, TAB4, and TAB TRANSVERAL SKILLS, compiled based on the following criteria:

- TAB1: courses offered by the Degree Program in Automation and Control Engineering, taught in the 1st Semester
- TAB2: courses offered by the Degree Program in Automation and Control Engineering, taught in the 2nd Semester
- TAB3: courses offered by other Degree Programs, taught in the 1st Semester
- TAB4: courses offered by other Degree Programs, taught in the 2nd Semester
- TAB TRANSVERAL SKILLS: courses on soft/transversal skills, either offered by the Degree Program in Automation and Control Engineering or by other Degree Programs, taught in either the 1st or the 2nd Semester.

Rules for study plan composition:

- Minimum 20 ECTS from **TAB1** and **TAB2**.
- Maximum 10 ECTS from **TAB TRANSVERAL SKILLS** and possibly other courses not in the tables (subject to approval).
- Maximum 1 course among “Project work”, “Smart wearables design and prototyping”, “Technology for health and social challenges” and “Robotics laboratory”.
- To include in her/his study plan a course that pertains to one of the thematic areas but is not part of the offering of the Degree Program, a student must include at least one course belonging to **TAB1** or **TAB2** that pertains to that thematic area.
  Example: to include a course on energy systems that is not part of the offering of the MSc Degree Program, a student must include also at least one course among Advanced process control, Automation of energy systems, and Power electronics and supplies

TAB1 (offered by the Automation and Control Engineering Program, 1st semester), all 5 ECTS

CODE	FIELD	TITLE
056807	IINF-04/A	AUTOMATION AND CONTROL IN AUTONOMOUS VEHICLES
064493	IINF-04/A	COLLABORATIVE, INTELLIGENT AND HUMANOID ROBOTICS
064839	IINF-04/A	CONTROL OF MOBILE ROBOTS
052354	IINF-04/A	DATA DRIVEN CONTROL SYSTEM DESIGN
095901	IINF-04/A	ICT FOR CONTROL SYSTEMS ENGINEERING
064492	IBIO-01/A	MEDICAL ROBOTICS
052369	IINF-04/A	NETWORKED CONTROL
097469	IINF-04/A	NONLINEAR CONTROL
062047	IINF-04/A	NUMERICAL OPTIMIZATION FOR CONTROL

052353	IIND-02/A IIND-08/A IINF-04/A	PROJECT WORK
064328	IINF-04/A	ROBOTICS LABORATORY
051197	IINF-04/A	ROBUST CONTROL
093060	IINF-04/A	SAFETY IN AUTOMATION SYSTEMS
094172	IINF-04/A	SYSTEMS THEORY (NONLINEAR DYNAMICS)
056808	IIND-02/A	VIBRATION CONTROL AND DIAGNOSTICS OF MECHANICAL SYSTEMS

TAB2 (offered by Automation and Control Engineering Program, 2nd semester), all 5 ECTS

CODE	FIELD	TITLE
055513	IMIS-01/A IMIS-01/B	ADVANCED MEASUREMENT SYSTEMS FOR CONTROL APPLICATIONS
097471	IINF-04/A	ADVANCED PROCESS CONTROL
055512	IIND-02/A IIND-08/A IINF-04/A	ADVANCED TOPICS IN AUTOMATION AND CONTROL ENGINEERING
064326	IINF-04/A	AERIAL ROBOTICS
056810	IINF-04/A	AUTOMATION AND CONTROL IN ELECTRIC AND HYBRID VEHICLES
090916	IINF-04/A	AUTOMATION OF ENERGY SYSTEMS
064327	IINF-04/A	CONTROL OF ROBOTIC MANIPULATORS
055514	IEGE-01/A	HIGH-TECH ENTREPRENEURSHIP
097470	IIND-08/A	POWER ELECTRONICS AND SUPPLIES
090915	IINF-04/A	PRODUCTION SYSTEMS CONTROL
097484	IINF-04/A	SIMULATION TECHNIQUES AND TOOLS

TAB3 (offered by other Study Programs, 1st semester)

CODE	FIELD	TITLE	ECTS
097313	IIND-04/A	ADDITIVE MANUFACTURING	5
052578	IIND-08/B	AUTOMAZIONE DEI SISTEMI ELETTRICI DI TRASPORTO	5
089194	IINF-04/A	COMPLESSITÀ NEI SISTEMI E NELLE RETI	5
062148	IIND-04/A	DIGITAL TWIN OF PRODUCTION SYSTEMS B	5
054654	IINF-01/A	ELECTRONIC SYSTEMS	10
099993	IINF-05/A	IMAGE ANALYSIS AND COMPUTER VISION	5
056893	IINF-05/A	MULTIAGENT SYSTEMS	5
089180	MATH-05/A	NUMERICAL ANALYSIS	5
094179	IMIS-01/B	OPTICAL MEASUREMENTS	5
090918	IINF-01/A	POWER ELECTRONICS	10
062242	IIND-05/A	SMART MAINTENANCE AND INDUSTRIAL ASSET MANAGEMENT	10

TAB4 (offered by other Study Programs, 2nd semester)

CODE	FIELD	TITLE	ECTS
051823	MATH-06/A	DISCRETE OPTIMIZATION	5
096221	ICHI-01/C	DYNAMICS AND CONTROL OF CHEMICAL PROCESSES	5
063501	IINF-05/A	FORMAL METHODS FOR SOFTWARE ENGINEERING (UIC 540)	5
054323	IINF-03/A	INTERNET OF THINGS	5
097485	IIND-03/A	MACHINE DESIGN	5
095896	IINF-04/A	NATURAL RESOURCES MANAGEMENT	10
051822	MATH-06/A	NONLINEAR OPTIMIZATION	5
052359	IINF-05/A	PERCEPTION, LOCALIZATION AND MAPPING FOR MOBILE ROBOTS	5
063591	IINF-01/A	SMART WEARABLES DESIGN AND PROTOTYPING	5
064288	IBIO-01/A IEGE-01/A IINF-04/A	TECHNOLOGY FOR HEALTH AND SOCIAL CHALLENGES	5
057504	IIET-01/A IINF-04/A	ADVANCED METHODS FOR THE OPTIMAL MANAGEMENT OF THE ELECTRICAL GRID	5

TAB TRANSVERAL SKILLS, all 5ECTS

CODE	FIELD	TITLE	SEMESTER
056931	IIND-08/B PHIL-02/A	POWER SYSTEMS: ETHICAL ISSUES AND SOCIAL IMPLICATIONS	2
057072	IIND-05/A	AGILE PROJECT MANAGEMENT	2
055806	PHIL-02/A	CRITICAL THINKING	2
055807	GSPS-05/A	EMERGING TECHNOLOGIES AND SOCIETAL CHALLENGES	2
056839	IMIS-01/B	ENGINEERING METHODS SUPPORTING JUSTICE	2
052581	PHIL-02/A	ETHICS FOR TECHNOLOGY	1
063139	HIST-03/A	HISTORY OF TECHNOLOGICAL INNOVATION	2
064254	IEGE-01/A	PATENTS AND INTELLECTUAL PROPERTY MANAGEMENT	2
052585	IINF-05/A	PERSONALITÀ, TEAM BUILDING, LEADERSHIP	2
063787	GIUR-01/A GIUR-04/A	TECHNICAL ACTIVITIES AND LEGAL IMPLICATIONS: LIABILITY, IP PROTECTION, AI REGULATION	2
062747	PHIL-03/A	ETHICS OF CLIMATE CHANGE	2
064834	GSPS-06/A IINF-04/A	DATA AND ALGORITHMIC FAIRNESS	2