POLITECNICO MILANO 1863

ENGINEERING SCIENCE

An international bachelor's degree bridging science and engineering foundations

COURSE HANDBOOK 2026/2027

March 2026

Disclaimer
The Focus areas and related courses described in this document are under development and represent the current academic proposals for the Engineering Science programme. As the programme will be progressively activated starting from 2026/2027, details may be subject to refinement.

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ENGINEERING SCIENCE AT A GLANCE

Engineering Science is built on a
structured dialogue between
science and engineering,
theory and practice,
and disciplinary and transversal competences.

The programme unfolds through a
progressive academic architecture:
breadth at the beginning,
orientation in the middle,
depth at the end.

KEY FACTS

Language

English

Duration

3 years – 180 ECTS

Location

Milano – Leonardo and Bovisa Campus

Start

September 2026

PROGRAMME STRUCTURE

CORE - Foundations

Integrated basic and engineering sciences

DIRECTION - Exploration

Exploring key engineering domains

FOCUS - Deepening

Courses within a chosen engineering area

Capstone Project

Interdisciplinary engineering project

EDUCATIONAL APPROACH

Student-centred learning model in which knowledge is progressively constructed through guided engagement.

Plenary sessions and small group activities, fostering active problem solving and project development.

Engineering Corners, Technology Briefs and Virtual Labs to strengthen the **dialogue between theory and application**.

FUTURE OPPORTUNITIES

Progressive and informed choice of Master of Science Programmes across the **full spectrum of engineering disciplines** at Politecnico di Milano.

Careers in **innovation, technology development, digital engineering, and interdisciplinary environments**.

VISION

Engineering Science is an international bachelor's degree designed to **build strong scientific and engineering foundations through an integrated, rigorous, and forward-looking approach**.

The name "**Engineering Science**" reflects the core identity of the programme: it establishes a **continuous and structured dialogue between scientific principles and engineering reasoning**.

Science provides the intellectual framework that sustains modelling, analysis, and design. **Engineering** gives direction, context, and purpose to scientific knowledge.

In a world shaped by rapid technological transformation, **long-term and time-resilient adaptability** depends on mastering fundamental principles and developing the **ability to connect domains, frame problems clearly, construct robust solutions**.

Engineering Science offers a **broad, coherent, and methodologically rigorous preparation** in mathematics, physics, chemistry, computer science, and engineering sciences. These areas evolve together from the first year, enabling students to progressively orient their studies while maintaining **intellectual openness**.

The course therefore avoids early fragmentation of foundational studies, favouring a broad and open approach that allows students to progressively build a solid disciplinary trajectory.

The result is a preparation that **combines depth with flexibility** — a solid foundation for advanced studies and for engaging confidently with the evolving challenges of contemporary engineering.

WHAT MAKES ENGINEERING SCIENCE DIFFERENT

An Integrated Foundation

The programme develops mathematics, physics, chemistry, computing, and engineering sciences not as parallel tracks, but as interdependent components of a **unified framework**. Scientific concepts and engineering interpretation are developed together from the beginning, rather than as sequential stages of learning. Students therefore learn early to move between abstraction and application, linking theoretical models to engineering interpretation and validation.

A Transversal Perspective

Engineering problems are rarely confined to a single discipline. The programme cultivates the **ability to relate tools, methods, and models across domains**, strengthening analytical flexibility and structured reasoning. This transversal perspective supports the development of durable problem-setting and problem-solving competences applicable to diverse technological contexts.

A Strong Methodological Core

Beyond disciplinary content, Engineering Science emphasises the **engineering method**: modelling complex systems, defining assumptions, analysing alternatives, validating results, and interpreting implications. Students progressively acquire a shared language and a rigorous intellectual discipline that supports both collaboration and independent judgement.

An Informed Focus

Engineering Science prepares students to choose — not to decide prematurely. After building a strong common foundation, students progressively align their studies toward a selected engineering domain (Engineering Focus), applying transversal competences within a disciplinary context. The Focus therefore represents a **structured opportunity for disciplinary deepening** built upon solid foundations.

A Strategic Launchpad

The programme functions as a strategic launchpad for advanced studies and innovation-driven environments. Graduates are equipped not only with knowledge, but with the intellectual structure required to **understand emerging technologies, integrate perspectives, and adapt to evolving professional landscapes**.

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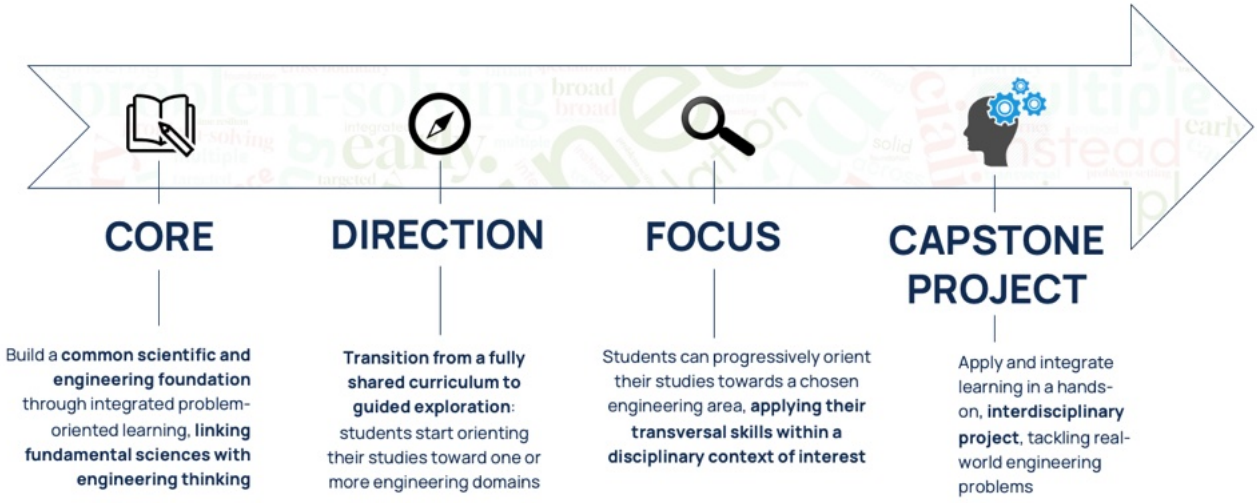
PROGRAMME

STRUCTURE

Engineering Science is structured as a progressive academic architecture: shared foundations, guided exploration, and coherent disciplinary development. The programme unfolds through **three areas — CORE, DIRECTION, and FOCUS** — culminating in a **Capstone Project**.



The overall architecture of the programme ensures coherence over time:
breadth at the beginning
orientation in the middle
depth at the end.

CORE AREA – Shared Foundations (120 ECTS)

Students build a common scientific and engineering foundation. These subjects are delivered through a problem-oriented learning approach, ensuring that scientific reasoning and engineering interpretation evolve together.

Year I

Semester	Course	ECTS
1	MATHEMATICAL ANALYSIS AND LINEAR ALGEBRA I	9
1	CHEMISTRY AND MATERIALS SCIENCE I	6
1	FUNDAMENTALS OF COMPUTER SCIENCE	9
1	DIGITAL MODELLING AND ENGINEERING DRAWING	6
2	MATHEMATICAL ANALYSIS AND LINEAR ALGEBRA II	9
2	MECHANICS: PHYSICS AND ENGINEERING I	6
2	THERMAL PHYSICS AND ENGINEERING I	3
2	FUNDAMENTALS OF MANAGEMENT ENGINEERING	9
2	EXPLORING ENGINEERING	3

Year II-III

Course
COMPLEMENTS OF MATHEMATICAL ANALYSIS
PROBABILITY AND STATISTICS FOR ENGINEERING
CHEMISTRY AND MATERIALS SCIENCE II
MECHANICS: PHYSICS AND ENGINEERING II
THERMAL PHYSICS AND ENGINEERING II
ELECTROMAGNETISM AND CIRCUIT THEORY I
ELECTROMAGNETISM AND CIRCUIT THEORY II
SCIENTIFIC OMPUTING AND MACHINE LEARNING

More information on CORE subjects is provided in **Appendix A**.

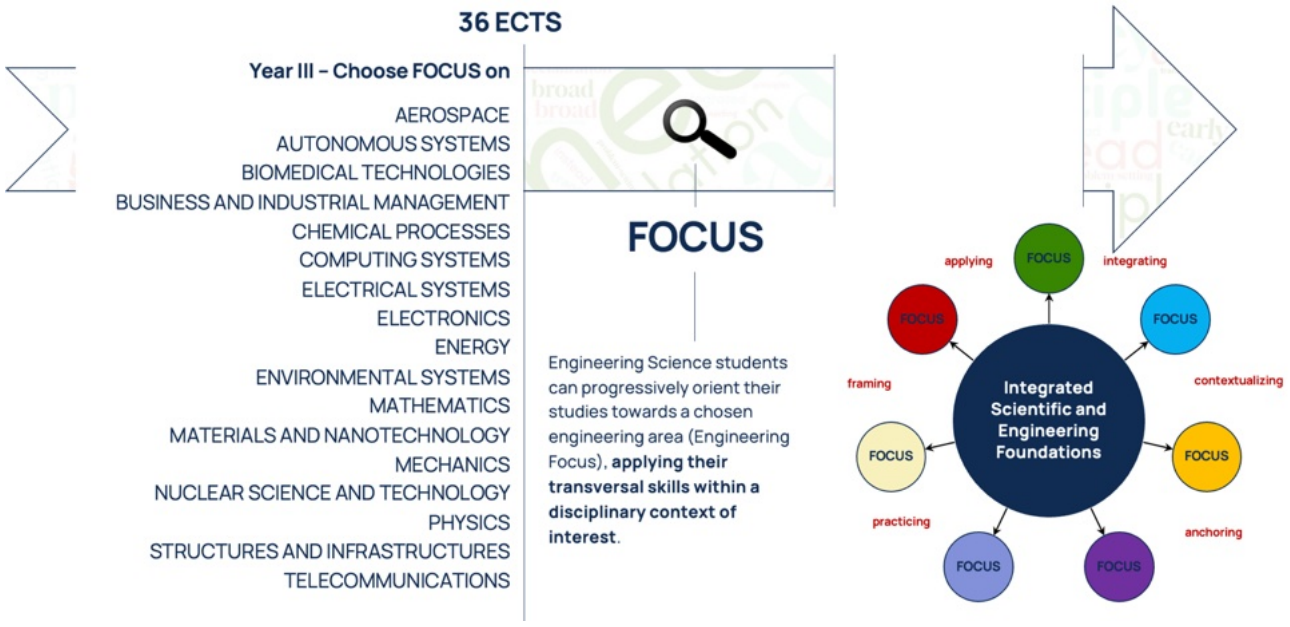
DIRECTION AREA – Guided Exploration (18 ECTS)

At the transition between the second and third year, students begin structured disciplinary exploration through selected courses. This phase allows students to test interests within a coherent framework, progressively aligning their preparation without narrowing options prematurely.

More information on DIRECTION subjects is provided in **Appendix A**.

FOCUS AREA – Coherent Development (36 ECTS)

In the third year, students select a Focus corresponding to a specific engineering domain. The Focus consolidates knowledge within a chosen area while building on the transversal competences acquired in the Core. This structure ensures depth without fragmentation.



More information on Focus Areas is provided in **Appendix B**.

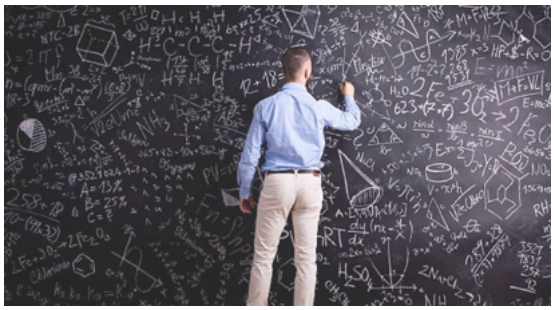
CAPSTONE PROJECT – Integration and Application (6 ECTS)

The programme concludes with a Capstone Project, a hands-on interdisciplinary experience addressing a real engineering problem.
The Capstone synthesises analytical, computational, and collaborative skills, reinforcing the capacity to integrate knowledge across domains.

TEACHING FOR LEARNING

Engineering Science adopts a
student-centred learning model
in which knowledge is progressively constructed
through guided engagement.
Learning is structured, active, and reflective.

All courses follow a shared pedagogical architecture:
Lead-on – Context and Framing.
Concepts are introduced within meaningful engineering contexts, clarifying relevance and motivation.
Minds-on – Concepts and Methods.
Theoretical models and analytical tools
are developed rigorously, strengthening formal reasoning.
Hands-on – Application and Validation.
Knowledge is applied through laboratories, simulations, programming tasks, and projects, consolidating understanding through practice and feedback.



Teaching integrates:
Plenary sessions,
providing conceptual structure and modelling guidance.
Small-group sessions, fostering active problem solving, experimentation, and project development.

Dedicated formats strengthen the dialogue between theory and application:

Engineering Corners
connect foundational concepts to concrete engineering cases.

Technology Briefs
illuminate how core principles underpin emerging technologies.

Virtual and experimental laboratories
including digital-twin environments, enable modelling validation.

Project-based learning activities
allow students to apply concepts and methods to realistic engineering problems.

PROFESSIONAL PATHWAYS
AND
MSc OPPORTUNITIES

Professional Pathways

Graduates are prepared for contexts where integration and innovation are central, including:

- Technology and strategic analysis
- Innovation and process development
- Business and technology development
- Digitalisation and data-driven engineering
- Sustainability and the technology–market interface

The programme equips students to operate in **evolving technological environments requiring adaptability and structured thinking**.

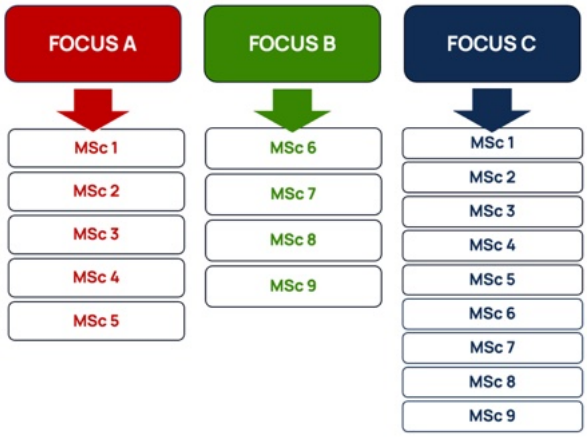
Pathways to Master of Science Programmes

Engineering Science is intentionally designed to remain **open to the full spectrum of Master of Science programmes in Engineering at Politecnico di Milano**.

Students do not commit to a single disciplinary track at entry. Instead, they build a harmonised scientific and engineering foundation that preserves **multiple academic pathways.**

Through the Direction courses and the Engineering Focus, students progressively align their preparation with specific MSc requirements.

The programme therefore supports **progressive and informed academic orientation**, enabling exploration, refinement of interests, and structured choice over time.
Choosing Engineering Science means **postponing premature narrowing of options**, while preserving the academic solidity required for any future specialisation within engineering. It functions as both a robust academic foundation and a coherent bridge toward advanced engineering studies.



THE STUDENT EXPERIENCE

Studying Engineering Science means joining an **international academic environment within one of Europe's leading technical universities**.

The programme is delivered **in English** and attracts students from diverse educational and cultural backgrounds, fostering **global perspectives and intercultural collaboration**.

Students study across:

- **Leonardo Campus**, near Milan's historical centre.
- **Bovisa Campus**, transformed from an industrial district into a modern academic hub.

Together, the two campuses form a unified academic ecosystem within the broader context of Milan's innovation landscape.

Students benefit from
tutoring services,
student associations,
cultural and sports activities,
and initiatives dedicated to inclusion and wellbeing.

Academic excellence is complemented by active participation in university life.

Each student is assigned an **Academic Tutor**,
a faculty member of the programme,
who provides **guidance and support throughout the study path**.

The Academic Tutor helps students understand the structure and expectations of the programme, reflect on their progress, and make informed decisions about study choices, workload management, and learning strategies, while also **supporting their academic orientation and integration into the university environment**.

ENTRY REQUIREMENTS

Access is possible through:

- TOL (in Italian)
- TOLC-I (in Italian)
- CEnT-S (in English)
- SAT (in English)

The programme is delivered entirely in English.

Applicants must demonstrate proficiency in English.

Italian is not required for admission; however, students must achieve at least a B2 level in Italian before graduation.

For updated information, please refer to www.polimi.it.

Appendix A – Core and Direction Areas

Courses and learning outcomes.

CORE

Mathematical Analysis and Linear Algebra I (9 ECTS)

The aim of the course is to provide engineering students with a solid and coherent foundation in Mathematical Analysis and the basic concepts of Linear Algebra, focusing on the tools and reasoning most essential for scientific and engineering applications. Students will learn how to use mathematical language and symbolic computation with awareness and precision. The course includes examples drawn from real-world engineering contexts (Engineering Corners) reinforcing learning and fostering a more unified and informed understanding. It makes use of additional material (notes, quizzes, exercises) to support individual study and skill development. The course actively promotes student participation through problem-solving practices, encouraging the autonomous application of acquired knowledge and critical analysis of solutions.

Chemistry and Materials Science I (6 ECTS)

The course provides the fundamental concepts for the study of atomic structure and chemical bonding, with the aims of:

- Showing and explaining how atoms are organized into lattices (covalent, metallic or ionic), molecules or macromolecules and how microscopic structure influences the macroscopic properties of materials.
- Describing the states of aggregation of matter (gas, liquid, solid).
- Introducing the basic concepts of thermodynamics and chemical kinetics to understand the chemical transformations of matter.
- Giving a first overview and classification of materials for engineering uses.

Some classes of chemical reactions are described in detail, such as acid-base reactions and oxidation-reduction reactions (electrochemical processes and corrosion phenomena).

Fundamentals of Computer Science (9 ECTS)

The course aims to introduce the fundamental concepts of computer science, covering the following aspects:

- The characteristics of computer systems, their organization, and the functionalities they provide.
- The methodologies for defining and solving problems through an algorithmic approach.

- The fundamental concepts of programming, mainly using the C language to provide solid foundations in the computational and algorithmic approach.
- The application of the introduced concepts through problem-solving and practical use of the programming language.
- The transfer of the introduced concepts to a language oriented towards numerical computation, data handling, and machine learning, such as Python.

The concepts and methods will be described through examples in the C language. An introductory discussion of the Python language will be provided, covering similarities and differences between the two languages.

Digital Modelling and Engineering Drawing (6 ECTS)

The course provides first-year engineering students with the foundational knowledge and practical skills in digital modelling and engineering drawing necessary to support the design, analysis, and communication of engineered systems across industrial, civil, and information engineering domains. It aims to build students' ability to interpret and produce 2D and 3D representations of components and systems, fostering spatial reasoning, multidisciplinary awareness, and readiness for more advanced design tools and methods. The course comprises a few introductory lectures followed by practical sessions focused on the creation of digital models and engineering drawings drawn from different engineering fields. In the final part of the semester, students work in teams on a project of their choice, allowing them to deepen their skills in a specific application area aligned with their interests.

Mathematical Analysis and Linear Algebra II (9 ECTS)

The course aims to provide engineering students with advanced tools from Mathematical Analysis and Linear Algebra necessary for modeling, analyzing, and solving problems in applied sciences and engineering. The Mathematical Analysis part deepens the study of functions of one and several variables, while the Linear Algebra component introduces more abstract and computational tools. The objective is to consolidate students' ability to reason rigorously, manipulate complex structures, and understand their applications. The course includes examples drawn from real-world engineering contexts (Engineering Corners) reinforcing learning and fostering a more unified and informed understanding.

Mechanics: Physics and Engineering I (6 ECTS)

The course provides a solid introduction to classical mechanics, with particular emphasis on applications relevant to engineering. Students will acquire the tools needed to model and solve kinematic and dynamic problems involving simple mechanical systems.

At the end of the course, students will be able to:

- Understand the fundamental concepts of Mechanics: space, time, velocity, acceleration, force, work, and energy.
- Apply the fundamental laws of classical mechanics to systems of material points, including the ability to analyse motion in non-inertial reference frames.
- Model the dynamic behaviour of simple mechanical systems using appropriate mathematical formalisms.
- Formulate and solve basic engineering problems related to the motion of objects, including both direct and inverse dynamics problems.

Thermal Physics and Engineering I (3 ECTS)

The course aims to provide fundamental understanding of thermal phenomena and basic thermodynamic principles. It introduces the physical quantities, concepts, and laws governing the behavior of substances under thermal interactions, establishing the groundwork for more advanced studies in energy systems and heat transfer. Students will develop the ability to translate physical phenomena into mathematical expressions and to interpret the physical meaning of thermodynamic processes through an integrated physics–engineering perspective.

Fundamentals of Management Engineering (9 ECTS)

The course aims to provide students with a solid foundation of the concepts and tools of management engineering. It is designed to introduce the fundamentals of financial accounting and cost analysis, and the criteria for investment evaluation. It also provides a foundational understanding of the key variables characterizing industrial systems, from both a strategic and operational perspective. Through lectures, practical exercises, and case studies, students are expected to acquire the capacity to interpret financial and industrial data, to critically assess business performance, and to make informed decisions within complex organizational contexts. Emphasis is placed on fostering awareness of the social and environmental implications of managerial choices, to prepare students to act as responsible engineers and decision-makers.

Exploring Engineering (3 ECTS)

The course introduces students to the culture and identity of the engineering profession, emphasizing the role of engineering in historical, social, and economic development. It provides a structured understanding of the core principles of the engineering method, spanning problem definition, design, experimentation, and continuous improvement. Through laboratory activities, the course promotes ethical awareness and social responsibility in technological

decision-making, strengthens transferable skills such as communication, collaboration, and problem-solving, and fosters connections between first-year foundational courses and their future application in real-world engineering contexts.

Complements of Mathematical Analysis (6 ECTS)

The course aims to provide engineering students with even more tools from Mathematical Analysis necessary for modeling, analyzing, and solving problems in applied sciences and engineering. The topics deal with the integration theory for functions of several variables and generalities on Fourier series. The objective is to consolidate students' ability to reason rigorously, manipulate complex structures and to introduce them to some abstract tools of functional analysis understanding their applications.

Mechanics: Physics and Engineering II (9 ECTS)

This module consolidates and expands the students' ability to define mathematical models of mechanical systems and use them in combination with computational methods to deal with typical problems and methods in mechanical engineering and other related technology sectors.
Students will learn to:

- Understand the mechanical behavior of a single rigid body and of systems of rigid bodies interconnected by constraints, highlighting the effect of constraint forces.
- Write the equations of motion of mechanical systems in planar motion, using Newtonian dynamics, and energy methods, including Lagrange equations.
- Analyze quantitatively and assess the dynamic behavior of machines and other mechanical systems across a wide range of operating conditions (e.g. run-up, steady state, run-down), using appropriate mathematical models and numerical tools.
- Understand the general problem of dynamic stability in mechanical system and describe vibrations in systems having one degree of freedom, including free motion and the effect of harmonic and periodic excitation.
- Apply the acquired knowledge to typical problems of design and sizing of mechanical systems, e.g. the definition of the workspace of a robot, the choice of transmission ratios in a ground vehicle, vibration isolation.

Chemistry and Materials Science II (6 ECTS)

The course introduces materials science and engineering with the following aims:

- To complement the educational background in general chemistry achieved in module I with an introduction to the chemistry of carbon atoms (chemistry of organic structures).
- To show and explain what are the more relevant mechanical and functional properties of the different classes of materials (metals, polymers and ceramics, including silicon), and how they can be measured.
- To show and explain the general concepts of durability and degradation.
- To develop a rational approach towards materials selection in engineering applications.

Some examples of characterization techniques and measurements in a virtual laboratory will be given, using video tools and a digital-twin approach, that will involve also raw data elaboration and processing, and interpretation of results by students operating in interactive working groups.

Electromagnetism and Circuit Theory I (9 ECTS)

This course aims to provide students with a solid foundation in electromagnetism and circuit theory, with the ultimate goal to present the subject in a unified and harmonized framework.
By exploiting adequate physical concepts and mathematical formalism, the fundamental ideas behind the comprehension of the electromagnetic laws (Maxwell's equations) will be developed. Starting from Maxwell's equations, electrostatics, magnetostatics, low-/high-frequency electrodynamics will be introduced and properly developed to provide the students with the physical knowledge to understand circuit theory.
In the first module, Maxwell's equations are introduced, clarifying their structure, from the microscopic formulation in vacuum to the macroscopic equations describing EM in matter. Circuit Theory will be then introduced as an approximate solution of these equations, and fundamental knowledge for the analysis of linear electrical circuits will be provided with particular attention to the analysis of circuits under steady-state, sinusoidal, and transient conditions.
To support the comprehension of theoretical concepts, the course will include dedicated interactive modules (experimental and simulation Labs) and short Technical Briefs aimed at illustrating the fundamental principles behind modern electrical applications.

Electromagnetism and Circuit Theory II (6 ECTS)

This course aims to provide students with a solid foundation in electromagnetism and circuit theory, with the ultimate goal to present the subject in a unified and harmonized framework.

By exploiting adequate physical concepts and mathematical formalism, the fundamental ideas behind the comprehension of the electromagnetic laws (Maxwell's equations) will be developed.
Building upon the knowledge of Maxwell's equations and circuit theory gained in the first module, the second module introduces electrostatics, magnetostatics, low-/high-frequency electrodynamics to provide the students with the physical knowledge to understand the physics behind electrical circuits (e.g., Kirchhoff's laws) and circuit components. This allows students to approach the theory and analysis of magnetic circuits in analogy with electrical ones, and to apply them to derive circuit models for coupled inductors, fundamental for understanding the operation of static and rotating electrical machines.
To support the comprehension of theoretical concepts, the course will include dedicated interactive modules (experimental and simulation Labs) and short Technical Briefs aimed at illustrating the fundamental principles behind modern electrical applications.

Thermal Physics and Engineering II (9 ECTS)

This course builds upon the foundations established in *Thermal Physics and Engineering I*, deepening the understanding of thermodynamics and introducing the principles of heat transfer and thermal systems engineering. It aims to develop the ability to model, analyze, and assess the performance of thermodynamic systems and energy conversion devices, integrating theory with computational and applied engineering methods.

Probability and Statistics for Engineering (6 ECTS)

The course aims to provide students with the mathematical language and methods necessary to represent and analyse random phenomena. It will introduce the fundamental concepts of probability theory, the main probabilistic models, and some basic statistical techniques. The course is designed to develop the ability to describe, quantify, and estimate the inherent uncertainty in various phenomena, with particular focus on applications in the engineering field. To this end, examples drawn from real-world contexts ("Engineering Corners") will be presented, and educational materials — available online — will support individual study and enhance knowledge. Practical exercises are also planned, using - as a tool - programming languages geared toward statistical analysis, such as Python, to promote active and applied learning.

Scientific Computing and Machine Learning (9 ECTS)

The course aims to define the general context, the conceptual framework, and the terminology for the field of artificial intelligence and statistical and machine

learning, with an approach oriented towards problem solving. In particular, the course will describe the main methods for statistical learning (SL) and machine learning (ML), both supervised and unsupervised, with references to the general context of scientific computing and artificial intelligence. The methods will be described with an operational and applicative focus, starting from the definition of the problem to be tackled, and then concentrating on the selection and application of the optimal solution. The topics will be addressed through several practical examples and project activities (based on the Python programming language), not overlooking the theoretical foundations upon which the proposed technical solutions are based. The objective is to train knowledgeable and conscious users of machine learning methods and tools, capable of successfully employing these strategies in various areas of engineering.

DIRECTION

Solid Mechanics (9 ECTS)

The course introduces students to the fundamental principles that govern the mechanics of deformable solids and structural elements. Starting from the basic concepts of stress and strain, students will learn how materials deform and resist external loads, and how these concepts lead to the equations of linear elasticity. The course also covers the analysis of beams and trusses under various load conditions axial, bending, torsion and shear. A key objective is to provide the tools needed to evaluate the strength and stiffness of structures, applying both analytical methods and the basics of the Finite Element Method for practical problem-solving. Throughout the course, students are encouraged to connect theory with engineering applications, developing a solid understanding of how mechanical principles are used in structural analysis.

Fundamentals of Electronics (9 ECTS)

The course provides a foundational understanding of the operating principles of the main electronic devices and components, including diodes, transistors, operational amplifiers, analog-to-digital and digital-to-analog converters, logic gates, and sequential logic elements. The course equips students with the theoretical and practical tools required to analyze and design both analog and digital electronic circuits. In addition, the course aims to develop the student's ability to approach unfamiliar problems, identify appropriate electronic solutions, and design effective circuit implementations to address specific functional requirements.

By the end of the course, students will acquire the following competencies.

- Understanding the physical principles underlying electron devices (diodes, MOSFETs).
- Ability to analyze and design fundamental analog circuits, including MOS-based linear stages and OpAmp-based systems.

- Ability to analyze frequency response, stability conditions, and dynamic behaviors of linear systems.
- Knowledge of analog-to-digital and digital-to-analog conversion systems, including performance metrics, error analysis, and component selection.
- Mastery of the fundamentals of digital electronics, such as logic gates, combinational circuits, and sequential systems.
- Designing analog, digital, and mixed-signal circuits based on functional specifications.
- Selecting appropriate components and architectures for mixed-signal systems.
- Performing performance evaluations of analog and digital circuits.

Fluid Mechanics (9 ECTS)

Fluid Mechanics introduces the fundamental physical principles governing the behavior of fluids at rest and in motion, equipping students with analytical and computational tools required to model and characterize fluid flows in a wide range of engineering applications. Building upon core concepts of continuum mechanics and conservation laws, the course integrates theoretical foundations with engineering practice, emphasizing formulation and solution of fluid-flow problems relevant to engineering science.

Central topics include kinematics of fluid motion, hydrostatics, control-volume analysis, flow descriptions grounded on the Navier–Stokes equations, internal and external flows, elements of boundary-layer theory, and dimensional analysis for physical and geometric similarity. The course extends these foundations with an introduction to flows dynamics, including turbulence principles, offering students a first exposure to modern simulation-based engineering approaches. Throughout the course, students will learn to assess modeling assumptions, interpret experimental and numerical flow data, and assess and apply dimensionless quantities such as the Reynolds and Mach numbers to characterize flow regimes and guide design decisions.

A combination of lectures, interactive problem-solving sessions, and laboratory/virtual simulation activities supports development of engineering fluency with fluid phenomena ranging from pipe and channel flows, lift and drag concepts, and hydraulic systems, to emerging applications such as microfluidics processes. By the end of the course, students will be able to identify appropriate modeling assumptions, apply fundamental equations to real engineering problems, evaluate design alternatives, and communicate fluid-mechanics-based arguments effectively. Students completing this course will be prepared for advanced study in engineering.

Systems and Control Methods for Engineering (9 ECTS)

The course aims to provide students with a broad and rigorous understanding of system theory and control, emphasising its fundamental principles and its unifying role across engineering and applied sciences. Students will explore the dynamic behaviour of physical, technological, and socio-technical systems, learning to model and analyse their response under various conditions, to understand how feedback can be used to influence performance, robustness and operating conditions, and to perceive the "control" nature of many design problems across engineering domains.

Appendix B – Focus Areas

List of Focus:

1. Aerospace
2. Autonomous Systems
3. Biomedical Technologies
4. Business and Industrial Management
5. Chemical Processes
6. Computing Systems
7. Electrical Systems for Energy Transition
8. Electronics
9. Energy
10. Environmental Systems and Sustainability
11. Materials and Nanotechnology
12. Mathematics
13. Mechanical Systems
14. Nuclear Science and Technology
15. Physics
16. Structures and Infrastructures
17. Telecommunications

FOCUS

1. Focus on Aerospace

The Focus on Aerospace introduces students to the fundamental principles and methods of aerospace engineering, with emphasis on aerospace systems, flight mechanics, propulsion, and structures. Students deepen their understanding of the physical phenomena governing atmospheric and space flight, using analytical and computational tools to approach simplified aerospace engineering problems and gaining a first insight into how foundational knowledge is applied within this domain.

Courses may include:

- Introduction to Aerospace Engineering
- Aerospace Propulsion
- Aerospace Technologies and Materials
- Measurements and Instrumentation

2. Focus on Autonomous Systems

The Focus on Autonomous Systems explores the methods and technologies to design engineered systems that operate without human intervention. These systems integrate sensing, to monitor the behaviour of the environment, actuation, to influence such behaviour, and control logics, to autonomously carry out the assigned task. Students learn the working principles and selection approaches of measurement and actuation devices, and how to design and deploy control strategies for automated systems, such as industrial robots, discrete production systems, and energy and thermo-hydraulic processes.

Courses may include:

- Process Control
- Discrete Event Systems
- Electrical Machines and Drives
- Fundamentals of Robotics
- Measurements and Instrumentation

3. Focus on Biomedical Technologies

The Focus on Biomedical Technologies brings together engineering methods and life sciences to address problems related to biological systems and health-related technologies. It considers how quantitative models and analytical tools can be applied to describe biological phenomena and to support the development of biomedical devices. Attention is given to the interaction between artificial systems and living tissues, as well as to the integration of mechanical, electronic, and chemical approaches in medical applications. The

Focus offers a structured perspective on how engineering competences can be contextualised within medicine and the life sciences.

Courses may include:

- Biomechanics
- Biomedical Electromagnetics and Instrumentation
- Chemical Bioengineering
- Medical Informatics Fundamentals
- Principles of Bioimaging
- Introduction to Microsystems for Biomedical Applications
- 3D Modelling Tools for Biomedical Devices and Biological Structures

4. Focus on Business and Industrial Management

The Focus on Business and Industrial Management explores the interaction between engineering systems and economic, organizational, and managerial dynamics. It is designed to introduce students to topics such as business management, industrial production systems, macroeconomic analysis, data-driven decision-making, and organizational behaviour. Students learn to analyse production processes, interpret economic indicators, and support managerial decisions using quantitative methods. The Focus aims to provide the tools needed to approach engineering problems within complex socio-technical contexts, considering technical performance, economic sustainability, and organizational factors.

Courses may include:

- Macroeconomics
- Business Management and Organization
- Industrial Plants Management
- Business Data Analytics
- Organizational Behavior

5. Focus on Chemical Processes

The Focus on Chemical Processes is designed to provide a foundation in chemical engineering, with emphasis on thermodynamics, transport phenomena, industrial chemical processes, and unit operations. Students deepen their understanding of mass and energy balances, phase and reaction equilibria, and the mechanisms of heat, mass, and momentum transfer. The courses integrate theoretical principles with practical applications, including the analysis and design of chemical equipment, reactors, and separation processes, supported by laboratory activities. By choosing this Focus, students apply their analytical and design skills to fundamental chemical engineering problems, particularly in process analysis and equipment design.

Courses may include:

- Industrial Chemistry
- Transport Phenomena
- Unit Operations of Chemical Plants
- Thermodynamics for Chemical Engineering

6. Focus on Computing Systems

The Focus on Computing Systems examines the core principles of computer science and information science that underpin modern computing systems and digital technologies. It covers areas such as programming, algorithms, computer architecture, operating systems, databases, computer networks, software engineering, and artificial intelligence. Students explore how information is represented, processed, stored, and transmitted within hardware and software systems, developing strong analytical thinking and computational problem-solving skills. The Focus provides a framework for designing, implementing, and managing reliable, scalable, and intelligent software systems in an increasingly interconnected digital world.

Courses may include:

- Algorithms and Data Structures
- Computer Architectures
- Operating Systems
- Databases and Information Systems
- Computer Networks
- Software Engineering
- AI and Machine Learning
- Human–Computer Interaction

7. Focus on Electrical Systems for Energy Transition

The Focus on Electrical Systems for Energy Transition introduces students to the fundamental principles of electrical energy systems, including electrical machines, power systems, and electrical/electronic measurement. Students deepen their understanding of electricity generation and conversion, as well as the operation of power networks with distributed and renewable energy sources, using analytical and modelling tools to approach simplified problems related to electrical devices and power systems, and gain a first insight into how foundational knowledge is applied within this domain.

Courses may include:

- Electrical Machines and Drives
- Renewable Energy Sources in Power Systems
- Electrical Safety

- Measurements and Instrumentation

8. Focus on Electronics

The Focus on Electronics is designed to address the fundamental principles of analog and digital electronic systems, including circuit analysis and signal processing. Students deepen their understanding of analog electronic circuits, digital systems, and the techniques used to analyse and process signals. The courses combine theoretical concepts with practical activities, including the modelling and design of electronic circuits and systems. The Focus also provides an introduction to the physical foundations of electronic devices and their role in modern technologies. Through this pathway, students develop the ability to analyse and design electronic systems using appropriate engineering methods.

Courses may include:

- Analog Electronic Circuits
- Digital Electronic Systems
- Signal Processing
- Solid-State Electronics
- Optoelectronics
- Microcontrollers
- Electromagnetic Fields

9. Focus on Energy

The Focus on Energy is centred on the principles of energy conversion and fluid machines, with particular attention to thermal and power generation systems. It considers the behaviour of fluids in motion and their interaction with machines, as well as the operation and performance of energy systems. Students explore the application of mass and energy conservation to closed and open systems, analysing efficiency and environmental impact. The Focus also presents the fundamentals of indoor environmental control, with particular attention to the assessment of energy consumption in the integration of buildings and HVAC (heating, ventilation, air conditioning) systems.

Courses may include:

- Fundamentals of Indoor Environment Control
- Power Generation Systems and Environmental Impact
- Fluid Machines
- Measurements and Instrumentation

10. Focus on Environmental Systems and Sustainability

The Focus on Environmental Systems and Sustainability provides an interdisciplinary perspective on the natural environment, encompassing air, water, soil, and ecosystems, and the processes that govern environmental changes. It emphasises the use of models and analytical approaches to assess hazards and design effective mitigation strategies. By integrating knowledge across disciplines, the Focus enables students to interpret complex environmental phenomena and understand their implications across different spatial and temporal scales, developing the ability to evaluate impacts and identify solutions that balance technological development with environmental protection. Attention is given to engineering tools for informed decision-making, aimed at minimising impacts and improving system performance. The interconnection between human and ecosystem health is also addressed through methodological approaches and decision support systems that guide sustainable choices. Graduates are equipped to tackle pressing environmental challenges with technical skills as well as awareness and responsibility

Courses may include:

- Environmental Quality and Pollution Dynamics
- Geoinformatics for Environmental Data Analysis
- Engineering Geology and Hydrogeological Systems
- Soils and Hydro-Mechanical Processes
- Quantitative Methods for Environmental Modelling and Decision Support Systems

11. Focus on Materials and Nanotechnology

The Focus on Materials and Nanotechnology considers the scientific principles governing the behaviour, processing, and performance of materials across different length scales. It introduces the relationship between structure and properties, as well as the thermodynamic and transport phenomena underlying material transformations. Attention is given to nanoscience concepts and to the technological processes used in materials manufacturing and characterisation. The Focus offers a coherent framework for understanding how materials are designed, analysed, and applied in engineering contexts.

Courses may include:

- Thermodynamics of Mixtures and Transport Phenomena
- Introduction to Nanoscience
- Manufacturing Technologies
- Structural Materials
- Measurements and Instrumentation

12. Focus on Mathematics

The Focus on Mathematics develops advanced analytical and quantitative skills for the rigorous modelling of complex systems. It provides a strong foundation in continuous and discrete mathematics, numerical methods, and data analysis, equipping students with the theoretical and computational tools required to address complex scientific and technological problems. Particular emphasis is placed on mathematical modelling, computational techniques, and the interpretation of quantitative results in applied contexts such as quantum sciences, computational mathematics, statistics and data science, and quantitative finance, ensuring the ability to engage with high-level theoretical and applied topics in these fields.

Courses may include:

- Advanced Mathematical Analysis
- Numerical Analysis
- Elements of Modern Physics
- Quantitative Methods for Business, Economics, Finance and Data Analysis
- Computational and Statistical Modelling

13. Focus on Mechanical Systems

The Focus on Mechanics develops the principles and methods required for the analysis and design of mechanical systems. It is centered on system modelling, structural analysis, and the mechanical design process, with attention to the translation of functional requirements into reliable engineering solutions. Students examine the dimensioning and verification of components and assemblies, considering structural integrity, fatigue behavior, and failure mechanisms. The pathway integrates mechanical design with materials science, providing the tools to relate material properties to performance, durability, and operating conditions. It also addresses manufacturing processes and production constraints, highlighting the interaction between design choices and industrial realization.

Courses may include:

- Fundamentals of Machine Component Design and Analysis
- Mechanics of Vibrations
- Fluid Machines
- Design Methods and Tools
- Manufacturing Technologies
- Structural Materials
- Measurements and Instrumentation

14. Focus on Nuclear Science and Technology

The Focus on Nuclear Science and Technology develops an understanding of the physical and mathematical principles underlying radiation fields and nuclear systems. Emphasis is placed on modelling physical processes and examining the operating mechanisms of nuclear technologies. Topics such as nuclear engineering, radiation protection, and elements of modern physics provide the basis for analysing safety aspects and environmental implications. The Focus offers a structured framework for studying systems in which nuclear technologies and ionising radiation play a central role.

Courses may include:

- Introduction to Nuclear Engineering
- Principles of Radiation Protection
- Mathematical Analysis III
- Elements of Modern Physics
- Fluid Machines

15. Focus on Physics

The Focus on Physics for Engineering develops a deeper understanding of the physical principles underlying modern engineering applications. It addresses advanced topics in classical and modern physics, together with the mathematical methods required for their analysis. Students engage with concepts related to the structure of matter, optics and laser physics, radiation phenomena, and theoretical modelling. The Focus provides a coherent framework for applying rigorous physical reasoning to complex engineering problems.

Courses may include:

- Elements of Modern Physics
- Advanced Optics and Lasers
- Mathematical Analysis III
- Structure of Matter
- Principles of Radioprotection

16. Focus on Structures and Infrastructures

The Focus on Structures and Infrastructures provides the physical, conceptual, and methodological foundations needed to understand and manage the full lifecycle of structural and infrastructure systems. It covers key stages from design and construction to assessment, monitoring, and maintenance. The focus area addresses major civil infrastructure, including buildings, bridges and tunnels, water and energy systems, and transportation networks. Students explore the design and lifecycle management of both existing and new assets,

with emphasis on innovation, resilience, and sustainability. The Focus highlights the interaction between structures and environmental and human-induced actions, including extreme conditions, and how these influence long-term performance. Through this approach, students develop the ability to evaluate, design, and manage infrastructure systems, contributing effectively to sustainable development.

Courses may include:

- Principles of structures and infrastructures design
- Soil mechanics and earth constructions
- Infrastructures for transportation, hydraulic constructions
- Measurement and Monitoring Tools
- Design and Construction Management

17. Focus on Telecommunications

The Focus on Telecommunications examines the principles underlying modern communication systems and networks. It covers areas such as signal processing, communication systems, interconnection technologies, and network architectures. Students explore how information is transmitted, processed, and managed across wired and wireless systems, and gain insight into the physical mechanisms of transmission channels and the operation of communication networks. The Focus provides a framework for understanding the analysis and functioning of contemporary telecommunication systems.

Courses may include:

- Communication Systems
- Fundamentals of Signal Processing
- Interconnection Systems
- Fundamentals of Communication Networks
- Software Defined Networking
- Network Security
- Devices for Transmission
- Applied Electromagnetism