Politecnico di Torino

ACADEMIC REGULATIONS
Master's degree programme
in
NANOTECHNOLOGIES FOR ICTs

Department of Electronics and Telecommunications
Collegio di Ingegneria Elettronica, delle Telecomunicazioni e Fisica

Academic Year **2025/2026**

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SUMMARY

Art. 1 – Specific learning objectives and career prospects

1.1 Specific learning objectives

Master's graduates in Nanotechnologies for ICT are able to carry out research, design and development at the forefront of technology, working on the manipulation of matter at the micrometric and nanometric scale. This work involves not only the use of advanced components and methodologies, but also the development of new ones to enable innovative applications. This requires the ability to manage complex projects based on a deep understanding of material properties at the nanoscale and the related manipulation techniques, with the aim of designing and fabricating micro- and nanosystems that perform at the limits of technological feasibility. Graduates are also capable of developing new components and subsystems tailored to specific needs, including integrated systems. They can apply innovative methods and processes to manufacture nanodevices.

Applications range from various sectors of information and communication technologies (telecommunications, information processing, measurement and sensing, Internet of Things) to other areas of engineering where miniaturization and innovation are key to enabling functionality and performance —such as energy, biomedical applications, transportation, aerospace, robotics, environmental monitoring and consumer products.

Micro- and nanotechnologies are now widely adopted across industry, services and everyday life, offering new solutions and opportunities in a broad range of fields. On the design side, graduates are able to analyse application needs and translate them into design specifications, including in the case of complex micro- and nanosystems.

1.2 Career prospects

The Master's degree programme aims to train a variety of professional profiles. The career prospects and the main functions and competencies associated to each profile are illustrated below.

Professional profile	Main functions and competencies
Designer of Micro - and Nanodevices / Designer of Micro- and Nanosystems	Functions: Graduates of the Master's degree programme in Nanotechnologies for ICT contribute to the design and optimisation of micro- and nanodevices that can be integrated into electronic and microelectronic circuits or into complex systems of various kinds, starting from given specifications. They select materials, manufacturing processes, and micro/nanodevices, taking care of the integration of active and passive components, the overall system design, and the final testing. Depending on the application, a nanodevice designer must be able to develop sensors, actuators, microfluidic devices and other components whose functionalities are based on quantum transport phenomena in systems where electrons are confined at the nanometric scale, or on other physical phenomena related to micro/nanoscale dimensions and surface/interface effects. These devices can be integrated into systems for a wide range of applications in micro- and nanotechnologies for ICT. Application areas include data and signal acquisition and processing, even from extremely low-intensity sources such as biological systems, as well as information storage, processing and transmission. Application fields include ICT, medicine, agrifood, energy and the environment. Competencies: Key competencies for this role include a thorough understanding of quantum physics, solid-state and surface physics and electron transport in low-dimensional systems such as ultrathin layers, hybrid multilayers, and nanowires. Graduates must also master the main techniques for synthesising, processing and characterising artificial materials used in nanotechnologies and exhibiting quantum confinement and surface effects. Other required skills include knowledge of microelectronic circuit design, optical and photonic devices, microelectromechanical and microfluidic systems, and computational methods for simulating, modelling, and designing nanostructured materials and microsystems. Graduates are also capable of conducting and analysing laboratory measurements, including process control, nanoscopic morphological characterisation at different process stages and physical characterisation of functional nanomaterials.

	Potential employers: Nanodevice designers with a Master's degree in Nanotechnologies for ICT have excellent employment opportunities due to their specific and unique professional profile. They can work in a variety of Italian and European companies in the electronics, microelectronics, and high-tech sectors. Topics covered in the programme are aligned with several key priorities of recent EU Framework Programmes. In the Italian national research plan, micro/nanotechnologies play a crucial role among strategic objectives. This confirms that nanotechnologies are, and will remain, a strategic sector for all advanced economies. Graduates benefit from an English-taught programme, as proficiency in English is essential to operate effectively and stay up to date in the field of nanotechnologies and advanced technologies. In both specialist tracks, students benefit from a multicultural environment with international students from all over the world.
Research Engineer in Micro- and Nanotechnologies / Research Engineer in Micro- and Nanosystems	Functions: Graduates of the Master's degree programme in Nanotechnologies for ICT carry out fundamental and applied research in laboratories and industrial settings, where new types of nanomaterials are developed or novel physical phenomena related to micro- and nanotechnologies are explored. Research in these fields is typically conducted in multidisciplinary teams involving engineers, physicists, chemists, materials scientists, and biologists. Graduates are able to synthesise new nanomaterials and design novel devices, thanks to their theoretical and practical expertise in advanced techniques for material growth, preparation, and processing. They are also able to study the structural, morphological, and physical properties of individual nanomaterials and to develop hybrid systems that integrate different nanomaterials. Competencies: Key competencies include in-depth knowledge of the behaviour of matter at the nanoscale, including electrons and elementary excitations such as phonons, magnons, and excitons in low-dimensional metallic and/or semiconductor systems (e.g. ultrathin films, surfaces and interfaces, hybrid multilayers, nanowires). Graduates must master laboratory techniques for the preparation and processing of nanomaterials, with special focus on surface nanomanipulation using atomic force methods, micrometric and submicrometric spatial resolution techniques for structural and morphological characterisation, and surface contaminant detection. They must also be proficient in physical characterisation of new nanomaterials and surfaces. A sound theoretical knowledge in advanced condensed matter physics and mathematical modelling is also essential. Graduates have the necessary skills to design, develop and characterise new nanomaterials in response to specific industrial needs or to advance the state of the art through international research activities. They are prepared to actively contribute to advanced research projects funded by national or European bodies. Potential employers: Graduates of the Master's degree programme in Nanotechnologies for ICT working in nanotechnology research may find employment in R&D departments of Italian and European high-tech companies. The subjects covered in the programme closely align with several key areas of the most recent European Framework Programmes. In the Italian national research plan, micro/nanotechnologies represent a significant and strategic focus. This confirms the strategic relevance of nanotechnologies for all advanced economies. The English-language curriculum gives graduates a significant advantage, as English is essential for effective professional performance and for staying up to date in the fast-evolving field of nanotechnologies and advanced technologies. In both tracks, students benefit from the international and multicultural environment created by peers from many different countries.
Developer of Micro- and Nanotechnologies / Developer of Micro- and Nanosystems	Functions: Graduates of the Master's degree programme in Nanotechnologies for ICT contribute to the development of micro- and nanotechnologies for ICT applications in biomedicine and biology, energy, and the environment. Developers must be able to design, according to requirements, detection and actuation systems, microfluidic and analysis systems (even complex ones), largely based on chip-integrated microelectronics and relying on the functioning of one or more micro/nanodevices. They must also be able to organise such integrated systems to optimise performance, increase structural and functional robustness, and enhance portability. Application areas include detection of environmental contaminants in trace concentrations, single-molecule detection in biological environments, selective filtration of harmful molecules, micromanipulation of biological tissues, energy storage and production, and environmental and food

	monitoring. Competencies: Key competencies include deep knowledge of material properties at the nanoscale, microelectronics, advanced optical and photonic devices, micro-electromechanical systems, and micro/nanotechnologies for energy, environmental, and biomedical applications. Skills in micro/nanomanipulation and nano processing techniques are also essential. Developers of micro- and nanotechnologies can design and develop new technologies tailored to specific client needs. They are qualified to work actively in industrial development laboratories and to collaborate synergistically with researchers with complementary expertise. Potential employers: Graduates of the Master's degree programme in Nanotechnologies for ICT specialising in technology development can find employment in R&D departments of electronics, microelectronics, and high-tech companies operating in the energy, biomedical diagnostics, automation, robotics, and ICT sectors in Italy and across Europe. The contents of the programme align closely with many key areas of recent European Framework Programmes. In the Italian national research plan, micro/nanotechnologies are key to strategic goals. This confirms their long-term strategic importance for advanced economies. The English-taught curriculum offers graduates a significant advantage, since English is essential for professional effectiveness and ongoing learning in nanotechnologies and advanced technologies. In both specialist tracks, students benefit from a multicultural environment with international students from all over the world.

1.3 Professional profiles (ISTAT codes)

With reference to the list of professional profiles classified by ISTAT (Italian National Institute of Statistics, https://www.istat.it/en/), graduates from this Master's degree programme can work as:

ISTAT code	Description
2.2.1.4.1	Ingegneri elettronici

Art. 2 – Admission requirements

Italian regulations on enrolment in Master's degree programmes require Italian universities to check that applicants meet the following requirements:

- have a **three-year Bachelor's degree or university diploma**, or **other educational qualification obtained outside Italy** and recognized as suitable for admission;
- meet specific curricular requirements;
- have an **academic performance considered suitable** for admission.

CURRICULAR REQUIREMENTS

As far as curricular requirements are concerned, applicants must have a Bachelor's degree or a three-year university diploma, or an educational qualification obtained outside Italy and recognized as suitable for admission. In addition, they must have gained specific knowledge and competencies during their previous academic path (credits in specific Scientific Disciplinary Fields).

In particular, applicants must have earned:

- minimum 40 credits earned in the following core Scientific Disciplinary Fields (settori scientifico-disciplinari): base CHIM/07, FIS/01, FIS/03, ING-INF/05, MAT/02, MAT/03, MAT/05
- minimum 60 credits earned in the following specific Scientific Disciplinary Fields (settori scientifico-disciplinari): CHIM/07, FIS/01, FIS/02, FIS/03, FIS/04, ING-IND/22, ING-IND/31, ING-IND/33, ING-INF/01, ING-INF/02, ING-INF/03, ING- INF/04, ING-INF/05, ING-INF/06, ING-INF/07, MAT/06, MAT/07, MAT/08.

The credits of the Scientific Disciplinary Fields found both in the first group and in the second group are primarily counted for the first group. The remaining credits are counted for the second group. Therefore, the credits of a course can be counted partly to reach the minimum number of credits of both groups.

Applicants who lack less than 10 credits can be admitted to the programme by the Academic Advisor of the degree programme. For applicants who lack more than 10 credits, the evaluation will be subject to the final approval of the Coordinator or the Vice coordinator of the degree programme.

Applicants who do not meet the curricular requirements are required to make up for their unfulfilled curricular requirements (missing credits) before enrolment, by means of:

- **enrolment in single courses in order to make up for unfulfilled curricular requirements**: this is possible for students who need to earn up to a maximum of 60 credits. Students who enrol in single courses for this reason are allowed to include in their Personal Study Plan exclusively the courses assigned by the evaluator.
  or else,
- **credit transfer at Bachelor's level**: this is possible for students who need to earn more than 60 credits. In this case, students need to enrol in the Bachelor's degree programme that offers the credits in the specific Scientific Disciplinary Fields (core subjects and commentary subjects) required for admission to this Master's degree programme.

SUITABLE ACADEMIC PERFORMANCE

Applicants must have a suitable academic performance and an English language certificate (B2 level or above, as defined by the Common European Framework of Reference for Languages: Learning, Teaching, Assessment - CEFR).

The academic performance will be assessed as follows.

1) Applicants from Politecnico di Torino

a) applicants can be admitted to the programme if they earned their Bachelor's degree in:
   - 4 years or less (1) - no exam average grade required
   - between 4 and 5 years (1) –exam weighted average grade required (2): ≥21/30
   - more than 5 years– exam weighted average grade required (2): ≥ 24/30

b) admissions by merit-based evaluation of the Evaluation Committee

Applicants who do not have the above-mentioned average grade can take an admission test if they earned their Bachelor's

degree in:

- between 4 and 5 years (1) –exam weighted average grade required (2): < 21/30
- more than 5 years– exam weighted average grade required (2): > 21/30 and < 24/30

provided that during their Bachelor's path the weighted average grade of the exams belonging to the Scientific Disciplinary Fields (settori scientifico-disciplinari) FIS/01-02-03 and ING-INF/01 is ≥ 24/30.

The details of the admission test are available in the section below "Merit-based evaluation for applicants from Politecnico di Torino and from other Italian universities".

The weighted average grade is calculated on all accrued course credits (graded on a scale of 30) counting towards the achievement of the Bachelor's degree, after having subtracted the worst 28 credits.

The duration of the Bachelor's path is calculated on the basis of the number of academic years in which the applicant has been enrolled at the university, starting from the first enrolment in the Italian university system:

- for full-time students: the duration of the Bachelor's path is equivalent to the number of academic years of enrolment.
- for part-time students: each year of enrolment is counted as half-year.
- for full-time students taking part in the "Dual Career" programme: each year of enrolment is counted as half-year, as for part-time students.

In the event of credit transfer, the duration of the Bachelor's path must be increased proportionally to the number of credits that have been recognized by Politecnico (10-60 CFU =1 year, etc.). The worst 28 credits must be subtracted proportionally to the number of validated credits.

(1) Applicants must have graduated by the end of the December Graduation Period
*(2) The weighted average is calculated as follows: ∑(grade*credits) / ∑credits*

2) Applicants from other Italian universities

a) Applicants who have a Bachelor's degree awarded by another Italian university must have a weighted average grade of all the exams ≥ **24/30**, regardless of the number of years it took them to graduate. The weighted average grade (∑(grade*credits) / ∑credits) is calculated on all accrued course credits (graded on a scale of 30) counting towards the achievement of the Bachelor's degree, after having subtracted the worst 28 credits.
b) admissions by merit-based evaluation of the Evaluation Committee

Applicants with a weighted average grade > 21/30 and <24/30 can take an admission test (merit-based evaluation), provided that during their Bachelor's path the weighted average grade of the exams belonging to the Scientific Disciplinary Fields (settori scientifico-disciplinari) : FIS/01-02-03 and ING-INF/01 is ≥ 24/30.

The details of the admission test are available in the section below "Merit-based evaluation for applicants from Politecnico di Torino and from other Italian universities".

<u>Merit-based evaluation for applicants from Politecnico di Torino and from other Italian universities</u>

The merit-based evaluation (admission test) aims to ascertain specific requirements in order to verify that prospective students have the knowledge, competencies and aptitude to the contents and learning objectives of the Master's degree programme. The admission tests consist in an oral interview (it can also be a remote interview) about the subjects of the following Scientific Disciplinary Fields: : FIS/01-02-03 and ING-INF/01.
A positive evaluation (offer of admission) allows applicants to enrol in the programme only in the academic year in which the evaluation has been given. Admitted applicants who do not complete the enrolment process within the deadlines are required to apply again and retake the admission test in the next academic years.
Students from Politecnico who have been admitted to the programme and have advanced some Master's courses (taken during their Bachelor's path) are allowed to enrol without retaking the admission test also in the next academic year, provided that they meet the other admission requirements.

3) Applicants with a non-Italian educational qualification

To be admitted to Politecnico Master's degree programmes, applicants must have an academic qualification awarded by an accredited/recognized foreign university, earned after completing at least 15 years of total education (including primary school, secondary school and university).

Applicants who have attended a university programme lasting five or six academic years (different from the 3+2 system) without completing it must still meet the minimum requirement of 15 years of total education (of which at least 3 years at university level) and they must have earned at least 180 ECTS credits or equivalent. Pre-university courses or foundation years cannot be counted towards the minimum number of credits or the minimum numbers of years of total education mentioned above.

The applicant's academic performance and the consistency between the degree programmes offered by Politecnico and the applicant's previous academic background are assessed by the professors designated by Coordinator of the Collegio. The evaluation is carried out on the Apply@polito platform under the section called "Applicants with a non-Italian qualification."

A positive evaluation (offer of admission) allows applicants to enrol in the programme only in the academic year in which the application has been submitted. Admitted applicants who do not complete the enrolment process within the deadlines are required to apply again to the programme in the next academic years.

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Admissions to the international pathway "Micro and Nanotechnologies for Integrated Systems" (MNIS) is governed by specific agreements with École Polytechnique Fédérale de Lausanne and Institut Polytechnique de Grenoble. A specific call for applications for admission is published every year. The Call defines the number of available places, the admission requirements (curricular requirements, language requirements, and academic performance), the details of the admission test and the evaluation criteria used to determine the final ranking list.

More information is available at https://www.polito.it/en/education/applying-studying-graduating/admissions-and-enrolment/master-s-degree-programmes

Art. 3 – Programme curriculum

3.1 Programme overview

The Master's degree in Nanotechnologies for ICTs is entirely English-taught. The programme offers in-depth knowledge in solid-state physics, nanomaterial processing and characterization techniques, advanced electronic and photonic devices, nanotechnology applications, modern manipulation techniques for nanoscale objects, integrated microelectronic systems, and computer-aided nano design.
Students work on their Master's project either at Politecnico di Torino or at external public or private institutions, both in Italy and abroad, with which cooperation agreements have been established. Agreements with international universities also allow students to spend study periods and/or carry out the thesis project in collaboration with local supervisors. In some cases, double degree programmes are available.
The program is designed to build solid foundations in condensed matter physics, interface physics, and materials processing technologies—especially those originating from the ICT engineering field—while developing a wide range of competencies from the design to the implementation of nano electronic devices, micro and nano sensors, and micro and nano systems.
The programme combines advanced training in electronic and information engineering with specialised skills in condensed matter physics, aimed at the development of materials and processes for the design and fabrication of various micro- and nanodevices.
The curriculum provides comprehensive training in the core areas of micro- and nanotechnologies, complemented by in-depth courses on materials and system characterization techniques, optoelectronic devices, devices for biomedical nanodiagnostics, microfluidics, robotics, and information processing. Elective courses allow students to customise their curriculum either by focusing on specific technological areas (such as nanoelectronic devices, devices for biomedical applications, energy devices, or nanophotonic systems) or by building interdisciplinary paths that include substantial content from other engineering domains and condensed matter physics.

3.2 Organization of educational activities

The list of courses (compulsory and optional), curricula, possible organization of courses into modules, any pre-requisites and exclusions and the list of the faculty members responsible for the courses are available at: https://didattica.polito.it/pls/portal30/sviluppo.offerta_formativa_2019.vis?p_a_acc=2026&p_sdu=37&p_cds=572

The list of the Scientific Disciplinary Fields (Settori Scientifico Disciplinari) for each activity (specific subjects and complementary subjects) is available at: https://didattica.polito.it/pls/portal30/sviluppo.vis_aiq_2023.visualizza?sducds=37572&tab=0&p_a_acc=2026

Art. 4 - Student career

The Student Guide is published on the Teaching Portal every year before the beginning of the academic year. There is a specific Student Guide for each Master's degree programme. The Student Guide is available on the web site of the degree programme.

It contains information and deadlines on:

- academic calendar;
- Personal Study Plan and Annual Personal Study Plan;
- free choice credits;
- internships;
- tuition fees;
- dual career;
- classes and exams;
- class delivery;
- foreign language learning;
- studying abroad/mobility programmes;
- exam rules;
- transfers in/out and internal transfers;
- interruption, suspension, withdrawal, forfeiture;
- credit transfer.

Art. 5 - Final Examination

The final examination is worth 30 credits. Developing and writing a thesis normally requires a period of approximately 6 months of full-time work. The final examination consists of a 30-credit thesis or, alternatively, a 12-credit internship in a company followed by an 18-credit thesis.

The Final Examination involves an analysis, a project, or an innovative application, on a topic that must be consistent with the educational objectives of the degree programme. Students are required to write a final written document (Master's thesis).

The courses offered in Year 2 are organized in a way that leaves sufficient time for the development of the thesis. Students who have completed all the exams are eligible to be admitted to the final examination.

The Master's thesis serves as a comprehensive assessment of the student's mastery of technical content, organizational and communication skills, and individual work capabilities in relation to complex analyses or projects. The final examination typically requires the application of knowledge gained from multiple courses, the integration of additional elements and the ability to propose innovative ideas. The topic and the activities connected with the thesis must be agreed upon with a faculty member from the Politecnico (a thesis supervisor and an internship tutor, if this is the case). Students are allowed to work on their thesis project also at external organizations or companies, in Italy or abroad, under the supervision of a thesis supervisor from Politecnico and a tutor from the external institution.

Students are required to publicly present and discuss the preparation activities for their thesis and the corresponding results (oral defence) in front of a Graduation Examining Committee, who will evaluate both the work carried out and the presentation.

The Master's thesis and its oral defence must be in English.

Students must submit their thesis application and request the thesis topic online through a dedicated procedure available in their personal page on the Teaching Portal, under the section entitled "Thesis," in compliance with the Graduation Periods deadlines published in the Student Guide – Thematic Calendar Section.

The Graduation Examining Committees base their evaluations on the student's overall academic performance, assessing their intellectual maturity, capacity for independent critical thinking, and the quality of the work presented.

The final grade is given by the Graduation Examining Committee. Its members evaluate the overall average grade of all the exams on a scale of 110. The committee may add up to a maximum of 8 points, considering the following:

- quality of the thesis work (commitment, autonomy, methodological rigor, relevance of results achieved, etc.);
- thesis oral defence (clarity in presentation, etc.);
- outstanding results achieved during the academic path (number of honours, time to graduation).

A degree with honours (lode) may be awarded at the Committee's discretion if the total score is at least 112.51.
If the thesis meets the required standards, the Committee may grant the dignità di stampa (printing honour) only if the final grade is 110 cum laude and the Committee's decision is unanimous.

More Information and Deadlines:

- Student Regulations
- Student Guide

Diploma Supplement:
In compliance with article 11, paragraph 8, of Ministerial Decrees No. 509/1999 and 270/2004. Politecnico di Torino issues the Diploma Supplement, a document that can attached to a higher education qualification. It is designed to improve the transparency of international qualifications, as it provides the description of the curriculum successfully completed by the student. This certificate follows the European model developed by the European Commission, the Council of Europe and UNESCO – CEPES: it is issued in two languages (Italian-English) and it is composed of approximately 10 pages.

More information at https://www.polito.it/en/education/applying-studying-graduating/academic-experience/certificates-and-other-documents

Art. 6 - References

6.1 Student Regulations

The Student Regulations define the rights and responsibilities of students and set out the administrative and disciplinary rules that all students enrolled in a degree programme or in a single learning activity at Politecnico must abide by.

6.2 Other Regulations

Particular aspects of students' academic progress are governed by specific Regulations or Calls for Applications published on its website.
In particular:

- The Tuition Fee Regulations specify the annual tuition fees that students must pay. The procedure for requesting a tuition fee reduction is explained in a dedicated guide.
- The University Regulations on Funds for Student Mobility Abroad outline the principles and rules for awarding and disbursing mobility grants. Standard procedures apply to all types of mobility programmes with unified Calls for Applications published twice a year at https://www.polito.it/en/education/applying-studying-graduating/studying-abroad
- The Code of Ethical Conduct also applies to students.