Politecnico di Torino

ACADEMIC REGULATIONS
Master's degree programme
in
QUANTUM ENGINEERING

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

Academic Year **2025/2026**

The English translation of this document is provided as a support to the student community and has no legal effects. The Italian version shall constitute the sole authentic text and will be referred to for any legal matters.

SUMMARY

Art. 1 – Specific learning objectives and career prospects

1.1 Specific learning objectives

The Master's degree programme in Quantum Engineering is entirely taught in English.
The Quantum Engineering programme is strongly multidisciplinary, in line with its educational objectives, and is designed to enable graduates to apply quantum technologies across engineering fields in a cross-cutting and innovative way.
The programme's main goal is to train graduates with a multidisciplinary background that includes the mathematical, physical, electronic, and computer science skills required to effectively apply quantum technologies in the fields of communications, computing, and sensing.

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
Specialist in Quantum Computing	Functions: Specialists in Quantum Computing carry out the following functions: • develop applications based on quantum computers; • develop hybrid applications running partly on classical computers and partly on quantum computers; • contribute to the development of new quantum computers at different levels: qubit (hardware), architecture (high-level), and system (software compilation); • explore and assess new opportunities, applications and markets for quantum computing; • benchmark quantum computing solutions against classical implementations; • analyse the maturity of markets and technologies for the introduction of quantum computing systems. Competencies: Students learn to use and (partially) design quantum computers. Proficiency in using quantum computers is considered the most important skill, as it is expected to become increasingly widespread, similarly to what happened with classical computers. Key competencies include: • analysing, modifying, and designing quantum algorithms; • understanding major commercial software libraries for simulating and using quantum computers, both in a hardware-agnostic and hardware-specific context; • identifying application domains (e.g. finance); • analysing existing quantum technologies (qubit level); • designing new technologies for qubit implementation; • assessing quantum computer performance, including issues related to noise and decoherence. Transversal competencies: strong communication skills (both written and oral, also in English), analytical and synthesis abilities, rigorous methodological implementation, ability to operate in multidisciplinary environments. Potential Employers: The most immediate employment opportunities are in companies that develop hardware and software for quantum computing. Although these companies are still few worldwide due to the high sophistication of the technologies involved, they employ a significant number of people, particularly within large multinational corporations. A secondary market is also emerging, mirroring what happened in classical computing, composed of companies that use quantum computers to solve application-specific problems. Among these, the financial sector is particularly promising, especially for risk analysis. This market is expected to grow in the medium to long term.

	In addition to companies, research institutions—both national and international—play a key role, offering positions for researchers with a strong foundational background. This job market is already active and expected to expand in the coming years.
Specialist in Quantum Communication	Functions: Specialists in Quantum Communication carry out the following functions: • develop applications and technological solutions based on quantum effects and technologies for quantum communication; • design and implement experimental setups and testbeds for Quantum Key Distribution (QKD); • explore and assess new options, applications, and markets for implementing quantum communication systems; • benchmark quantum communication solutions against classical implementations; • analyse the maturity of markets and technologies for introducing new quantum communication systems. Competencies: All the functions listed above require a strong background in quantum technologies, especially in physics and mathematics. System-level and application-level development tasks demand additional design and development skills. The degree programme includes specific courses that teach students how to design and use intrinsically secure communication systems. Key competencies include: • understanding the use of photons to transmit the state of qubits between remote locations; • knowledge of single-photon sources and detectors for generating and engineering non-classical states of light; • leveraging the high immunity of photons to perturbations and low signal attenuation; • designing quantum communication systems to connect quantum computers and ensure extremely high security standards; • implementing quantum cryptography protocols based on quantum mechanics to guarantee secure data transmission; • designing transmission systems that rely on single-photon qubits, making any interception attempt detectable due to state disturbance; • developing secure protocols such as QKD (Quantum Key Distribution); • implementing quantum cryptography algorithms and quantum key error correction schemes; • designing quantum communication networks based on photonic devices such as quantum repeaters and quantum switches. Additional skills are required in classical electronics, measurement and software, to integrate quantum subsystems into complete systems. Transversal competencies: strong communication skills (both written and oral, also in English), analytical and synthesis abilities, rigorous methodological implementation, ability to work in multidisciplinary teams. Potential Employers: Main employment opportunities are in the telecommunications, network infrastructure, and cybersecurity sectors. In particular, the growing importance of communication network security has already created demand for experts in quantum communication and cryptography, both in Italy and abroad. Graduates may work in R&D divisions as well as in operational and service-oriented departments. Thanks to their training, graduates in Quantum Engineering are also well-prepared to contribute to applied research and the innovation of telecommunications systems.
Specialist in Quantum Sensing	Functions: Specialists in Quantum Sensing carry out the following functions: • develop applications and technological solutions based on quantum effects and technologies for various application domains; • design and implement experimental setups and testbenches for quantum sensing devices and related interfacing systems, including performance evaluation and optimisation algorithms; • explore and assess new opportunities, applications, and markets for implementing quantum

	sensing systems; • benchmark quantum sensing solutions against classical implementations; • analyse the maturity of markets and technologies for introducing new quantum sensing systems. Competencies: Students learn how to design and use measurement systems based on quantum sensors for a wide range of application sectors. These sensors may be based on photonic or solid-state systems and are expected to significantly outperform classical systems in many technological contexts. Key competencies include: • analysing multidisciplinary requirements for innovative sensing systems based on quantum principles; • using quantum mechanics formalism—including advanced mathematical aspects—for designing, modelling and simulating sensors under realistic conditions; • integrating quantum and classical devices in hybrid circuits; • designing technology flows for sensor fabrication, including scaling-up toward pre-industrial production; • selecting suitable technologies and materials for specific needs, such as miniaturisation (using micro- and nanotechnologies) or packaging; • applying electronics and information engineering skills for sensor interfacing, control, test bench development, characterisation, algorithm optimisation, and data analysis. Transversal competencies: strong communication skills (both written and oral, also in English), analytical and synthesis abilities, rigorous methodological implementation, ability to work in multidisciplinary environments. Potential Employers: Main employment opportunities are in high-tech companies of various sizes (often operating globally, thanks to the programme being taught in English) in strategic sectors such as microelectronics, defence, aerospace, energy and environment, and biomedical engineering. In the short term, graduates are expected to be employed mainly in R&D divisions. In the medium to long term, job opportunities are likely to expand across different industry sectors and roles. Additional opportunities can be found in basic and applied research, as well as in the field of metrology.

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
2.6.2.3.2	Ricercatori e tecnici laureati nelle scienze ingegneristiche industriali e dell'informazione

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): CHIM/07, FIS/01, FIS/02, FIS/03, FIS/04, ING-INF/05, INF/01, 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, INF/01, MAT/02, MAT/03, MAT/05, MAT/06, MAT/07, MAT/08, MAT/09, SECS-S/02, ING-IND/16, ING-IND/22, ING-IND/31, ING-IND/33, ING-INF/01, ING-INF/03, ING-INF/04, ING-INF/05, ING-INF/07.

Considering that the Master's degree programme in Quantum Engineering is strongly multidisciplinary, applicants are expected to have a solid background in the following areas:

- Fundamentals of physics (mechanics, thermodynamics, optics, electromagnetism)
- Fundamentals of solid-state physics
- Fundamentals of modern physics
- Fundamentals of electronics and electronic devices
- Fundamentals of chemistry and materials science
- Knowledge of micro- and nanoscale characterization techniques (e.g. SEM, TEM, AFM, Raman spectroscopy, XRD, XPS, profilometry, …)

The applicant's background will be assessed by verifying the content of the curriculum of the Bachelor's degree programme of origin.

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

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

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.

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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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 curriculum is organised over four semesters. Each semester offers educational activities designed to provide cross-disciplinary skills in the core areas of the Master's degree programme, including integrated courses. The distribution of credit across semesters has been carefully balanced, with 30 ECTS credits per semester (including the thesis credits in the final semester).

The first semester is designed to provide the foundational knowledge required to study the disciplines that support the most innovative applications of quantum technologies—such as quantum computing, secure communications, and quantum sensing—in the following semesters. In addition to core courses, the first semester includes two parallel study tracks. Each student will take two courses selected from a group of four modules, covering topics in technology, mathematics, computer science and physics. The aim is to provide students with the background needed to successfully complete the more specialised courses of the next semesters. The two modules will be assigned to each student according to their previous academic background.

Technical, computational, and communication training is complemented by dedicated laboratory activities, allowing students to gain hands-on experience and strengthen their engineering skills and professional competencies. The programme includes a significant number of credits dedicated to experimental and laboratory work, embedded in several courses: cleanroom micro- and nanofabrication laboratory, cryogenics laboratory, quantum photonics measurement laboratory, Qubit electrical measurement laboratory, Python programming laboratory, and more. These activities are complemented by the preparation of individual or group reports and/or projects, aimed at developing key skills for engineering professionals: the ability to apply a rigorous scientific method, to carry out proper data analysis, to communicate effectively (including in English), to work independently, to collaborate within a team, and to develop an awareness of protocols and safety regulations.

At the end of the programme students are required to write a Master's thesis focused on the technological, modelling, and system-level aspects of the application domains covered by the curriculum. Thanks to the international network of universities and research centres with which the faculty collaborates, students will have outstanding opportunities for working on their thesis project abroad, enriching their training with high-level scientific and international experience.

Since the programme deals with highly innovative engineering disciplines and rapidly evolving applications, particular attention will be paid to the continuous monitoring of international developments and the corresponding updates to the curriculum and course contents.

In addition to preparing students for careers in industry, manufacturing, and advanced services, the Master's degree programme also offers a solid foundation for continuing studies through Specializing Master's programmes, Postgraduate Schools, and Ph.D. programmes, both in Italy and abroad. This is made possible by the entirely English-taught curriculum and the opportunities to work in international laboratories, research centres and companies through both lab activities and the thesis project.

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=32&p_cds=576

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=32576&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 18 credits.

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). 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 (both theoretical and applicative), 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 (thesis supervisor). 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.