



NVAO • THE NETHERLANDS

INITIAL ACCREDITATION

WO-MASTER

QUANTUM INFORMATION SCIENCE &
TECHNOLOGY (JOINT DEGREE)

Delft University of Technology and Leiden
University

SUMMARY REPORT

23 JANUARY 2023

1 Peer review

The quality of a new programme is assessed by means of peer review. A panel of independent peers including a student reviews the plans during a site visit to the institution. A discussion amongst peer experts forms the basis for the panel's final judgement and the advisory report. The focus is on the curriculum, the teaching and learning environment, and student assessment.

The Accreditation Organisation of the Netherlands and Flanders (NVAO) takes a formal decision on the quality of the new programme based on the outcome of the peer review. This decision can be positive, conditionally positive or negative. Following a positive NVAO decision with or without conditions the institution can proceed to offer the new programme. Upon completion of the programme graduates are entitled to receive a legally accredited degree.

This summary report contains the main outcomes of the peer review. A full report with more details including the panel's findings and analysis is also available. NVAO bases an accreditation decision on the full report.

Both the full and summary reports of peer reviews are published on NVAO's website www.nvao.net. There you can also find more information on NVAO and peer reviews of new programmes.

2 Panel

Peer experts

- Prof. Dr. Ir. Wim van Petegem (chair), associate professor Engineering Technology Educational Research (ETHER), Faculty of Engineering Technology, Head of the Media and Learning Division, KU Leuven (Belgium);
- Prof. Dr. Margriet Van Bael (member), full professor at the Department of Physics and Astronomy and Vice Dean for Education at the Faculty of Science, KU Leuven (Belgium);
- Dr. Ing. Lorenzo Tripodi, Group Head, Computational Methods for Metrology and Sensors, ASML Research, Eindhoven (the Netherlands);
- Nienke Wessel, BSc (student-member), master student Computing Science: Specialisation Data Science, Radboud University, Nijmegen (the Netherlands).

Assisting staff

Yvet Blom (secretary)

Tinka Thede (NVAO policy advisor and process coordinator)

Site visit

Delft, 15 November 2022

3 Outcome

The NVAO approved panel reaches a positive conclusion regarding the quality of the new programme Quantum Information Science & Technology (joint degree) offered by Delft University of Technology (TU Delft) and Leiden University. The programme complies with all standards of the limited NVAO framework and the protocol joint degree for initial accreditation.

The master in Quantum Information Science & Technology (QIST) has an inspiring interdisciplinary profile meant to deliver deep generalists. Students will become professionals with extensive, advanced knowledge of quantum systems integration and expert knowledge in one of three application fields: quantum computing and simulations, quantum communications or quantum sensing and metrology.

The master is offered as a joint degree programme by TU Delft and Leiden University. The panel notes that both universities have signed a cooperation agreement. TU Delft is the coordinating university and therefore some tasks are done according to the rules and regulations of TU Delft such as quality assurance. Although TU Delft is the coordinating institute, both universities are equal partners regarding use of campuses, number of FTE's in the courses, and shared responsibilities for matters such as committees and financing. The panel concludes that the QIST master meets the quality level required by NVAO for joint degree programmes.

Industry representatives who have been involved with creating the programme, are enthusiastic about the results. The programme meets their need for highly trained conceptual professionals who can work with a wide range of different specialists. Strong elements of the programme include the homologation programme (which provides students with the necessary knowledge to be able to start the programme), core courses and multidisciplinary projects. The panel really appreciates the personal profile that students have to develop during the master. Students create their profile by choosing an application field, electives and orientation of their master's thesis project (research, design or business). During the programme, students receive excellent guidance from an enthusiastic and exceptionally skilled team of lecturers. The assessment programme has a wide range of different assessment methods and formative feedback that supports students' learning process.

TU Delft and Leiden University propose a two-year master (120 EC). The panel agrees with the two universities that the extent and complexity of the interdisciplinary master programme cannot be achieved in one year. Industry representatives agree and told the panel that the professionals they hire all completed a two-year master programme. The panel therefore recommends granting the TU Delft and Leiden University the right to offer the QIST master as a two-year master programme.

The panel is convinced of the quality of the proposed MSc QIST programme and assesses it as positive.

4 Commendations

The programme is commended for the following features of good practice.

1. Appealing profile – TU Delft, Leiden University and QuTech developed an appealing profile for the Quantum Information Science & Technology master. This profile is in line with industry needs.
2. Strong foundation – The curriculum offers a strong foundation for the future QIST professional and includes a homologation programme, multidisciplinary team projects and core courses.

3. Personal profile – Students create a personal profile by choosing an application field¹, electives and an orientation² for their master thesis. Students have to visit information markets to discover possible career options. Students get excellent guidance when creating their profile, with the help of lecturers, researchers, study advisors and the programme coordinator.

4. Multidisciplinary team projects - Groups of students with different profiles work together on a challenging, real-life quantum technology issue proposed by a company or institute affiliated with the quantum technological field. Industry representatives are looking forward to propose cases and support QIST students during these projects.

5. Student portfolio – Students reflect on their personal goals and individual progress in their student portfolios and form small portfolio groups under supervision of a mentor. The portfolio groups focus on peer coaching to promote reflection and constructive feedback skills.

6. Passionate and skilled staff - TU Delft and Leiden University have a passionate and skilled programme management team and committed lecturers. All lecturers are active quantum researchers who use their research expertise for the courses.

7. Sound procedures – The Board of Examiners and the faculties have set up sound and transparent procedures to maintain a high level of quality assurance.

5 Recommendations

For further improvement to the programme, the panel recommends a number of follow-up actions.

1. Adjust intended learning outcomes – Align the existing intended learning outcomes with the three application fields. Also, formulate clear intended learning outcomes that reflect the business orientation. Finally, make sure that the same terminology is used in all the intended learning outcomes.

2. Transferable skills – Include all skills in the learning objectives to ensure that students and lecturers know which objectives students must achieve in order to successfully complete the course.

3. Lessons learned - Check with other joint degree programmes how they solved logistic issues for students having to travel to two different campuses every week and make sure students feel welcome at both places.

4. Advisory board – Set up an advisory board with a wide range of industry professionals from all three application fields as soon as possible.

5. Diversity – Actively recruit from underrepresented groups for different positions and functions (for the advisory board and for teaching positions).

6. Comparable weight application fields - Ensure that a comparable weight is assigned to the three application fields, making sure that the teaching offering for the quantum sensing and metrology fields is really equivalent to the offering for the other two fields (quantum computing and quantum communication), including at the homologation phase.

7. Company collaboration - Give students who choose the research orientation the option to collaborate with companies and not just with research related institutes. The research orientation currently focuses too heavily on the academic research component, while companies are also involved in research.

¹ Application fields that students can choose from are: quantum computing and simulations, quantum communication, and quantum sensing and metrology

² Orientations that students can choose from are: research, design or business.

8. Uniform rubric – Ensure that the intended learning outcomes are correctly assessed. The panel doubts if that is the case with the current Faculty of Applied Sciences rubric. The rubric is mainly research oriented, not including aspects of the design and business orientation.

6 What comes next?

NVAO grants initial accreditation to a new programme on the basis of a panel's full report. The decision is valid for a maximum of six years. For conditional accreditation other regulations apply. Upon accreditation the new programme will follow the NVAO review procedures for existing programmes. NVAO publishes the accreditation decision together with the full report and this summary report.³

Each institution has a system of quality assurance in place ensuring continuous follow-up actions and periodic peer-review activities. Peer reviews help the institution to improve the quality of its programmes. The progress made since the last review is therefore taken into consideration when preparing for the next review. The follow-up activities are also part of the following peer-review report. For more information, visit the institution's website.⁴

7 Summary in Dutch

Het panel oordeelt positief over de kwaliteit van de WO-Master Quantum Information Science & Technology (joint degree) van de Technische Universiteit Delft en Universiteit Leiden. Dit is de uitkomst van de kwaliteitstoets uitgevoerd door een panel van peers op verzoek van de Nederlands-Vlaamse Accreditatieorganisatie (NVAO). Voor deze beoordeling heeft het panel gesprekken gevoerd met vertegenwoordigers van de master op 15 november 2022.

De Master Quantum Information Science & Technology (QIST) heeft een uitdagend interdisciplinair profiel gericht op het opleiden van 'deep generalists': professionals met uitgebreide, geavanceerde kennis van de integratie van kwantumsystemen en deskundige kennis in een van de drie toepassingsgebieden: quantum computing and simulations, quantum communications, of quantum sensing and metrology.

De master wordt aangeboden als een joint degree-programma van de TU Delft en de Universiteit Leiden. Het panel constateert dat beide universiteiten een samenwerkingsovereenkomst hebben getekend. De TU Delft is de coördinerende universiteit en daarom worden sommige taken, zoals kwaliteitszorg, uitgevoerd volgens de regels en voorschriften van de TU Delft. Hoewel de TU Delft het coördinerend instituut is, zijn beide universiteiten gelijkwaardige partners voor wat betreft het gebruik van campussen, het aantal fte's en het delen van de verantwoordelijkheid voor zaken als commissies en financiering. De logistiek van de master (studenten reizen wekelijks naar twee verschillende campussen) leidde tot het advies van het panel om te kijken hoe andere joint degree-programma's met dit specifieke probleem omgaan. Ondanks de logistieke zorgen concludeert het panel dat de QIST-master voldoet aan het door de NVAO gestelde kwaliteitsniveau voor joint degree-opleidingen.

Vertegenwoordigers uit het bedrijfsleven die betrokken zijn geweest bij de opzet van de masteropleiding, zijn enthousiast over de master. Het programma voorziet in hun behoefte aan hoogopgeleide conceptuele professionals die kunnen samenwerken met een breed scala aan verschillende specialisten. Het verplichte deel van het curriculum is goed uitgewerkt. Sterke elementen zijn onder meer het homologatieprogramma (waarmee studenten de benodigde basiskennis opdoen), kernvakken en multidisciplinaire projecten. Daarnaast waardeert het panel het persoonlijke profiel dat studenten tijdens de master opstellen, bestaande uit het maken van keuzes met betrekking tot een toepassingsgebied, keuzevakken en oriëntatie van hun masterproefproject (onderzoek, ontwerp of business). Studenten worden tijdens de

³ <https://www.nvao.net/nl/besluiten>

⁴ <https://www.tudelft.nl/en/> <https://www.universiteitleiden.nl/en>

opleiding uitstekend begeleid door een enthousiast en buitengewoon bekwaam docententeam. Het toetsprogramma kent verschillende toetsvormen en formatieve feedback die het leerproces van studenten bevorderen.

De TU Delft en de Universiteit Leiden stellen een programma van twee jaar voor (120 EC). Het panel is het met de vertegenwoordigers van de master eens dat de breedte en complexiteit van de interdisciplinaire masteropleiding niet te realiseren is in een programma van minder dan twee jaar. Daarnaast geeft het werkveld aan dat de professionals die zij inhuren allemaal een tweejarige masteropleiding hebben gevolgd. Het panel adviseert daarom om de TU Delft en de Universiteit Leiden het recht te verlenen om de master QIST als tweejarige masteropleiding aan te bieden.

Het panel concludeert dat het overtuigd is van de kwaliteit van de voorgestelde opleiding MSc QIST. De master heeft een duidelijke focus op de integratie van kwantumsystemen. Al met al beoordeelt het panel de kwaliteit van de opleiding als positief.

Meer informatie over de NVAO-werkwijze en de toetsing van nieuwe opleidingen is te vinden op www.nvao.net. Voor informatie over de Technische Universiteit Delft en de Universiteit Leiden verwijzen we naar de website van de instellingen. ⁵

⁵ <https://www.tudelft.nl/en/> en <https://www.universiteitleiden.nl/en>

The summary report was written at the request of NVAO and is the outcome of the peer review of the new programme Quantum Information Science & Technology (joint degree) of Delft University of Technology and Leiden University

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