QX01 – Introduction to quantum information

Open to undergraduate students with basics in mathematics, computer science, and physics.

Introduction :

Quantum technologies have developed for several years already within the field of what was initially called quantum information. For the past 3-4 years, it has been referred to as quantum technologies because potential applications are currently being developed and so it is now not only about theoretical concepts or about proving experiential principles. Major companies such as Google, Microsoft, Intel, IBM and more recently ATOS have shown a real interest in these new innovative technologies. Besides, there has been an exponential number of start-ups on these topics, the adoption of a European flagship project, and of a bill has been approved by the American Congress on this question. More recently, in January 2021, France has announced its 5-year, 1.8-billion euro quantum plan.

On top of these significant milestones, it is important to understand that these technologies lie essentially on properties and laws from quantum physics that are by no means predictive and therefore require short, mid and long term investment on research and training. UTT wants to be a leader on both these aspects in partnership with academics and industrialists such as ATOS and IBM, but also with government agencies such as the French DGA and DGSE.

Contents :

As mentioned above, quantum technologies involve knowing about quantum physics. Then, these technologies are based on some completely non-predictive physics principles such as quantum super position, quantum entanglement, or even non-cloning. Current engineering students at Universities worldwide do not all have the necessary background to understand these technologies and so we deem it essential to provide them early in their curriculum with academic training on these technologies as they are likely to be faced with them in their career.

Objectives :

This course gives the essential basics to understand the forthcoming new technologies in communications, calculus, or sensors. Industrialists will also contribute from time to time.

Provisional program :

All lectures to be delivered live on UTT's Youtube channel.

Lecture 1: Introduction to quantum information & technologies
Lecture 2: Classical information & computation
Lecture 3 : The qubit
Lecture 4: Quantum sensors : Quantum magnetometry
Lecture 5: Multiple Qubit and entanglement
Lecture 6: Quantum cryptography
Lecture 7: Measurements and operators
Lecture 8: Quantum gates
Lecture 9: Quantum algorithm + quantum parallelism
Lecture 10: Shor's algorithm

Lecture 11: Quantum Error Correction
Lecture 12: Introduction to Quantum Learning Machine
Lecture 13: Quantum technologies 1
Lecture 14: Quantum technologies 2

Besides the information below, the deadline for application is 6th of February.

Q: While reviewing the information provided, we noticed that the lectures appear to be already recorded and available on your YouTube channel (https://www.youtube.com/watch?v=tIvTc66WHos).

These are past lectures that can be watched as a preparation for the course but there will be new recordings of this semester's live sessions. The course is divided into lectures, tutorials and practical sessions. There will be live sessions :
Thursdays from 8:00 to 10:00 CET for the lectures
Mondays from 18:00-20:00 CET for the tutorials
Tuesdays from 17:00-20:00 CET for the practical sessions.
Lectures and tutorials will be recorded and therefore can be watched at a later time, but practical sessions have to be attended live. For the distance learners watching the recorded sessions of lectures and tutorials, they obviously won't be able to interact with the teachers but they will be able to ask questions via emails. The content of practical sessions will be different for those on site from those online, but everyone will still have to attend live either onsite or online.

Q: We would therefore appreciate some clarification regarding the course structure for virtual participants. In particular, could you kindly let us know whether there is a formal registration process for students,

We only need the names and email addresses of the students who want to join in. First come, first serve! Knowing that we'll take a maximum of 24 EUT+ students. The head teacher will then send all the required links to have access to the live sessions and / or to watch the recorded sessions.

Q: a defined time frame during which the course is considered active,

The course will follow our semester's dates, i.e. the first lecture will be delivered in the week of 16th February, and the tutorials and practicals will start only in the week of 2nd March. The course will close on the 26th of June.

Q: and an assessment or examination component through which students could earn ECTS credits?

There will be an online mid-term exam, a final exam in the week of 22nd June, and an assignment related to the practical sessions to turn in before the end of the semester. Successful students will be awarded 6 ECTS.

Q: Alternatively, we would be grateful for any information on how student participation is documented and what form of recognition or certification is foreseen for successful completion of the course, should this be intended as a fully virtual mobility option.

It will not be possible to officially enroll the participants into our university database. However, upon successful completion of the course, each student will receive a certificate, including the title of the course, the name of the student, the grade, and the number of ECTS. It will then be up to you to tranfer the ECTS or not.

However, it is also possible to watch the videos without enrolling to the course.
Related links and information :

UTT's Youtube channel : https://www.youtube.com/user/ChaineUTT

UTT's research : https://recherche.utt.fr/

UTT's Pr Christophe Couteau's webpage: https://recherche.utt.fr/light-nanomaterials-nanotechnologies-l2n/members/christophe-couteau

UTT's Graduate school : https://nano-phot.utt.fr/