Practical Realities of Quantum Computation and Quantum Communication

Schedule

Note: All graded assignments are due the last day of the course. Items preceded by a star (★) are graded.

WELCOME TO THE COURSE (35 min)

Take a Pre-Assessment to get a baseline of your understanding of the course material. Become familiar with the platform and course design.

- Entrance Survey (5 min)
- ★ Pre-Assessment (10 min)
  Suggested due date to keep pace: end of course
- Welcome (2 min)
- Course Discussion Forum (5 min)
- Course Webinar (5 min)
- Who's in the Course? (2 min)
- Who's Teaching the Course? (3 min)
- LinkedIn Community (3 min)

WEEK 1: The Ubiquity and Challenges of Noise (4-5 hrs)

In the first week of this course, you'll learn about noise, its impact on qubit coherence, and how it impacts gate operations. You'll also learn how noise is quantified and represented.

- Introduction (5 min)
- Classical and Quantum Noise (25 min)
- Representations of Noise on the Bloch Sphere (25 min)
- Noise in Superconducting Qubits and Noise Mitigation (35 min)
- ★ Check Your Understanding Questions* (30 min)
  Suggested due date to keep pace: end of Week 1
- ★ Graded Activity (30 min)
  Suggested due date to keep pace: end of Week 1
- Key Images (3 min)

* Check Your Understanding questions are spread throughout each week and are due at the end of the course.

WEEK 2: Practical Challenges Faced by Realistic Quantum Communications Today (4-5 hrs.)

In Week 2, you'll look at practical aspects of quantum communication, including photon loss and its impact on long-distance quantum communication. You will explore methods being developed to mitigate photon loss in order to enable larger-scale quantum communication.

- Introduction (15 min)
- Entanglement and Benchmarking (45 min)
- Practical Issues and Challenges for QKD (35 min)
- Deep Dive: Entanglement as a Physical Resource (35 min)
- ★ Check Your Understanding Questions* (30 min)
  Suggested due date to keep pace: end of Week 2
- ★ Graded Activity (30 min)
  Suggested due date to keep pace: end of Week 2
- Key Images (3 min)

* Check Your Understanding questions are spread throughout each week and are due at the end of the course.

Live Event This Week
Course Webinar with Course Instructor
More information in Welcome to the Course > Course Webinar section

WEEK 3: Realistic Quantum Computation Today - Challenges and Opportunities (4-5 hrs.)

The third week of the course focuses on the realities of quantum algorithms as they are performed on the noisy, intermediate-scale qubits available today.

- Introduction (15 min)
- Practical Benchmarking (15 min)
- Practical Algorithms (35 min)
- ★ Case Study: The Harrow-Hassadim- Lloyd Quantum Algorithm for Linear Systems (35 min)
  Suggested due date to keep pace: end of Week 3
- ★ Reflection and Review Activity** (1.5 hrs)
  Written Submission suggested due date to keep pace end of Week 3
  Peer Reviews suggested due date to keep pace: start of Week 4
- ★ Check Your Understanding Questions* (30 min)
  Suggested due date to keep pace: end of Week 3
- ★ Graded Activity (30 min)
  Suggested due date to keep pace: end of Week 3
- Key Images (3 min)

* Check Your Understanding questions are spread throughout each week and are due at the end of the course.

** Suggested date for the reflection submission and discussion forum posting is the end of Week 3. The suggested date for the peer reviews is beginning of Week 4. This will allow participants to stay on track with workload before Week 4's IBMQ experience activity.

WEEK 4: Benchmarking Techniques for Quantum Noise (4-5 hrs)

The fourth week of the course will focus on benchmarking quantum systems. You'll start the week by learning several benchmarking methods that quantify the robustness of quantum gates. Finally, you'll put into practice what you have learned in the IBM Quantum Experience practicum.

- Introduction (5 min)
- Benchmarking Quantum States (10 min)
- Benchmarking Quantum Gates (15 min)
- Case Study: Strategies for Benchmarking Noise in Superconducting Qubit Systems (25 min)
  ★ Lab Practicum: Characterizing Noise and Benchmarking Quantum Computers (IBM QE) (2 hrs)
  Suggested due date to keep pace: end of Week 4
  ★ Check Your Understanding* (30 min)
  Suggested due date to keep pace: end of Week 4
- ★ Graded Activity (30 min)
  Suggested due date to keep pace: end of Week 4
- Key Images (3 min)
- Exit Survey (10 min)
  Suggested due date to keep pace: end of Week 4
- ★ Post-Assessment (15 min)
  Suggested due date to keep pace: end of Week 4

* Check Your Understanding questions are spread throughout each week and are due at the end of the course.

After the Course Ends…

Download your course certificate. Continue to access the course materials.

Last day of the course

- Course ends at 23:30 UTC
- Discussion forums lock at 23:30 UTC

Four days after the course ends

- Course certificate available on MIT xPRO dashboard