

P550 - Quantum Devices I

Spring 2026

Professor: Rogério de Sousa

Number of UVic units: 1.5

Target audience

Graduate students in Science and Engineering at all levels, who want to obtain conceptual and practical understanding of quantum hardware for quantum computing and sensing applications. Part I of the course will cover devices based on superconducting circuits; Part II will cover quantum photonic circuits, emphasizing the similarity between both.

Prerequisites

Knowledge of quantum theory and electrical circuits at the undergraduate level. Some knowledge of quantum information science/technology.

Course date/time/location:

January 6 - March 31, 2026.

Wednesdays and Fridays from 10:00 am - 11:20am Pacific time.

The course is hybrid with in-person lectures and synchronous virtual lectures via zoom.

Overview

Building quantum computers is a great challenge and involves concepts and technology that have similarities and differences with those in conventional “classical” computers. It involves cryogenic electronics and in the currently most advanced approach it relies on superconducting and quantum circuits that display quantum effects. The topic of this course is superconducting and photonic quantum devices and circuits for quantum computers and sensors.

Learning objective

To become proficient in using models to predict the performance and behaviour of superconducting and photonic devices and circuits.

We will achieve this by teaching:

1. Fundamentals of superconductivity and its application to electrical circuits.
2. Quantum theory of electrical circuits made of superconducting wires and Josephson junctions. How to use them to make resonators, SQUIDs, qubits, quantum annealers, quantum amplifiers, etc.
3. Fundamentals of quantum optics and its application to photonic chips.
4. Introduction to the basics of photonic circuits and how to use them to make qubits and sensors.

Course evaluation/assessment

Class participation (30% of final grade)

Final course project (70% of final grade)

Class participation

Credit will be given for students that ask questions in class, and participate in discussions. Also for students that post questions in the BrightSpace forum, and answer questions posed by other students.

Final course project

There are three options for the final presentation: Students can present either (1) a recent paper from the literature; (2) a classic paper from the literature, describing a groundbreaking discovery; (3) a review paper or a book chapter, describing an important topic not covered in class. The deadline for choosing the paper or topic is October 22nd. Students are welcome to discuss possibilities with the instructor, and I am glad to suggest papers or topics.

Each student will be allotted 20 minutes for their presentation, plus 10 minutes for questions. On average, students should prepare ~ 15 slides.

Lecture materials

All lecture materials and assignments are available in the course's Brightspace:

<https://bright.uvic.ca/d2l/home/447143>

In particular, the lecture boards used in class and my handwritten notes will be made available online. These can be found under "Lecture boards" and "Lecture notes" in the content link.

Office hour

By appointment, please book a time with me at my email rdesousa@uvic.ca.

Textbook

For superconducting devices, we will use selected chapters of the book we are writing, "Superconducting Circuits and Quantum Devices", edited by Rogério de Sousa and Reza Molavi. For photonic circuits, we will use a selection of review articles (to be determined).

Final letter grade: UVic's percentage grading system

A+	90-100	Exceptional performance.
A	85-89	Outstanding performance.
A-	80-84	Excellent performance.
B+	77-79	Very good.
B	73-76	Good.
B-	70-72	Solid.
C+	65-69	Satisfactory.
C	60-64	Minimally satisfactory.

D	50-59	Marginal performance.
F	0-49	Unsatisfactory performance.

