QUANT-410

# Microwave engineering in physics

Manucharyan Vladimir

| Cursus | Sem. | Type |
|---|---|---|
| Ing.-phys | MA2, MA4 | Opt. |
| Physicien | MA2, MA4 | Opt. |
| Quantum Science and Engineering | MA2, MA4 | Opt. |

| | |
|---|---|
| Language of teaching | English |
| Credits | 4 |
| Session | Summer |
| Semester | Spring |
| Exam | Oral |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 2 weekly |
| Exercises | 1 weekly |
| Project | 1 weekly |
| **Number of positions** | |


## Summary

This course aims at teaching basic notions and tricks of microwave engineering to students with only an elementary knowledge of applied electromagnetism. Emphasis is made on topics that often arise in modern physics experiments, including quantum science and technology research.


## Content

- Review of basic notions in electromagnetism
- Lumped element circuits, impedance, telegrapher's equation, impedance matching
- Transmission lines
- Introduction to network analysis
- Impedance transformers
- Resonators

- Power dividers and hybrid couplers

- Non-reciprocal devices
- Noise in linear and non-linear circuits
- Amplifiers
- Microwave systems and system noise temperature
- Radiometry


## Keywords

Microwaves, low-noise measurements


## Learning Prerequisites

### Required courses

Linear algebra, calculus, differential equations, electromagnetism

### Important concepts to start the course

Working knowledge of complex numbers, calculus, and linear algebra; in-depth understanding of classical

Maxwell's equations.

## Learning Outcomes

By the end of the course, the student must be able to:

- Construct elementary microwaves-based measurement setups for table-top physics experiments
- Apply basic notions of electromagnetism to analyse microwave measurement setups

## Teaching methods

Lectures and demonstration, simulation projects, possibility of in-lab projects

## Expected student activities

Attending lectures, seminars, independent study, individual project study

## Assessment methods

Oral final exam (project presentation)

## Supervision

| | |
|---|---|
| Office hours | Yes |
| Assistant.e.s | Yes |

## Resources

### Bibliography

Course textbook: D. Pozar "Microwave engineering"
Course software: HFSS, Microwave Office

### Ressources en bibliothèque

- Find the references at the Library

### Moodle Link

- https://go.epfl.ch/QUANT-410