



COURSE DESCRIPTION CARD - SYLLABUS

Course name

High frequency and fast pulse techniques in quantum engineering [S1TK1E>TWCiKlWIK]

Course

Field of study

Quantum technologies

Year/Semester

3/5

Area of study (specialization)

–

Profile of study

general academic

Level of study

first-cycle

Course offered in

English

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

30

Laboratory classes

15

Other

0

Tutorials

0

Projects/seminars

0

Number of credit points

3,00

Coordinators

dr inż. Jarosław Szóstka

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Lecturers

Prerequisites

A student enrolling in this course should have basic knowledge of algebra, trigonometric functions, harmonic motion, electrical circuit theory (electrical components, impedance, current phase, complex phasor method), electronics (semiconductors, operating principles and parameters of transistors, amplifiers), quantum mechanics (phenomena utilized in quantum computers), and electrical metrology (measurements of voltage, current, and resistance; measurement uncertainty estimation). It should also possess the ability to calculate simple DC and AC electrical circuits, retrieve information from specified sources, and be ready to work collaboratively in a team.

Course objective

To prepare students to understand the fundamentals of transmission lines, as well as the design, operating principles, and microwave parameters of passive and active components used in quantum computers (superconducting, trapped-ion, and spin-based). To familiarize students with the quantities characterizing microwave circuits and with measurement instruments typical of microwave engineering, such as network analyzers and spectrum analyzers, and to introduce them to qubit control, readout, and synchronization systems.

Course-related learning outcomes

none

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. The knowledge acquired during lectures is verified through a written examination (duration: 60-90 minutes; descriptive answers to 3-5 questions, passing threshold: 50% of the total points for a grade of 3.0; the list of exam topics is available to students on the e-Kursy platform),
2. The knowledge and skills acquired during laboratory classes are verified based on the grades obtained from laboratory reports.

Programme content

none

Course topics

Laboratory

1. Health and safety (OSH) when working with 230 V electricity and in electromagnetic fields.
2. Measurement of scattering matrix (S-matrix) parameters of filters and amplifiers.
3. Measurements of selected microwave components fabricated in microstrip technology.
4. Wave propagation in waveguides.
5. Spectrum analyzer.
6. Network analyzer.
7. Measurements of transmission line parameters; quarter-wave and half-wave resonators.

Teaching methods

1. Traditional lecture (informative) with an emphasis on the physical interpretation of phenomena: a multimedia presentation supplemented by calculation examples and educational videos.
2. Laboratory classes: performing practical exercises in groups (2-4 students) based on written instructions.

Bibliography

Basic

1. Pozar D.M., Microwave Engineering, John Wiley & Sons, 2024.
2. Salari A., Microwave Techniques in Superconducting Quantum Computers, Artech House, 2024.
3. Lecture notes.

Additional

1. Bahl I., Bhartia P., Microwave Solid State Circuit Design, John Wiley&Sons, 2003.
2. Baranowski J., Nosal Z., Układy elektroniczne, cz. I i II, WNT, Warszawa 1993 (in Polish).
3. Gilmore R., Besser L., Practical RF Circuit Design for Modern Wireless Systems, vol. I & II, Artech House, 2003.
4. Szóstka J., Fale i anteny, Wyd. Komunikacji i Łączności, Warszawa, 2006 (in Polish).
5. Szóstka J., Miernictwo radiokomunikacyjne, Wyd. Politechniki Poznańskiej, Poznań, 2021 (in Polish).
6. Szóstka J., Mikrofałe. Układy i systemy, Wyd. Komunikacji i Łączności, Warszawa, 2006 (in Polish).
7. Wong H. Y., Quantum Computing Architecture And Hardware for Engineers. Step by Step, Springer Nature Switzerland, 2025.
8. Young P., Electronic Communication Techniques, Bell & Howell Company, 2003.
9. MIT Physics II: Electricity and Magnetism 8.02, Lectures by Walter Lewin (<https://www.youtube.com/watch?v=rtIJoXxlSFE&list=PLyQSN7X0ro2314mKyUiOILaOC2hk6Pc3j> dostęp 20.05.2026).
10. MIT Physics III: Vibrations and Waves 8.03, Lectures by Walter Lewin (https://www.youtube.com/watch?v=sf3XlpPtBo0&list=PLyQSN7X0ro22WeXM2QCKJm2NP_xHpGV89 dostęp 20.05.2026).

Breakdown of average student's workload

	Hours	ECTS
Total workload		
Classes requiring direct contact with the teacher		
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)		