

Photonic Integrated Circuits: Design and Applications (PICDA)

Summer Term 2024

– General Information –

Participating institutes:

Karlsruhe Institute of Technology (KIT)

Institute of Photonics and Quantum Electronics (IPQ)

<https://www.ipq.kit.edu/>

- Lecture: Prof. Christian Koos, Tel. 0721-608-42491, christian.koos@kit.edu
Prof. Sebastian Randel, Tel. 0721-608- 42490, sebastian.randel@kit.edu
Prof. Wolfgang Freude, Tel. 0721-608-42492, wolfgang.freude@kit.edu
- Tutorials: Alexander Kotz (MSc), Tel. 0721-608-42480
Adrian Schwarzenberger (MSc), Tel. 0721-608-47170
Yung Chen (MSc), Tel. 0721-608-48954
Hend Kholeif (MSc), Tel. 0721-608-42480
Contact: picda@ipq.kit.edu

RWTH Aachen University (RWTH)

Institute of Integrated Photonics (IPH)

<https://www.iph.rwth-aachen.de>

- Lecture: Prof. Jeremy Witzens, Tel. 0241-80-20020, jwitzens@iph.rwth-aachen.de
Dr. Ali Tabatabaei Mashayekh, Tel. 0241-80-20048, amashayekh@iph.rwth-aachen.de
- Tutorials: Dr. Ali Tabatabaei Mashayekh, Tel. 0241-80-20048, amashayekh@iph.rwth-aachen.de

Technische Universität Berlin (TUB)

Leibniz Institute for High Performance Microelectronics (IHP)

- Prof. Lars Zimmermann, Tel. 030-314-22437, l.zimmermann@tu-berlin.de
- Dr. Galina Georgieva, galina.georgieva@tu-berlin.de

Date and time: Monday, 11:30 – 13:00 h, Online / Hybrid
Thursday, 11:30 – 13:00 h, Online / Hybrid

Note to KIT students: Tutorial 10 (18. July) and Tutorial 11 (22. July) will be accompanied by short examination interviews of the presenting groups at KIT, see Section “Examination and grading” below. These tutorials will be held in hybrid format in Building 30.10, Room 3.42 at KIT, and the presenting groups are asked to join in person.

Online lectures and tutorials:

Online lectures and tutorials will be given via the online meeting service “Zoom” (<https://www.zoom.us/>). Please take care to always use the meeting link distributed via the respective online teaching platform of your university (see below).

Meeting link for the lecture and the tutorial:

<https://kit-lecture.zoom-x.de/j/67498442061?pwd=WU9mL2tONEdVeVFkUUUs4aWV5cExBZz09>

Alternatively, you can go to <https://www.zoom.us/>, click “Join a meeting” (“Einem Meeting beitreten”) at the top of the page, and enter the meeting ID and password manually:

Meeting ID: 67498442061

Passcode: 962493

Some important remarks on online lectures

- Before participating in a Zoom meeting, make yourself aware of the privacy information and remarks provided, e.g., by KIT under the following link: <https://www.zml.kit.edu/english/live-lecture-zoom.php>
- The lecture may be recorded by us and made available through the online teaching platform of the respective institution. This includes the presentation as well as the video and the voice of the lecturer. Participants' videos will not be part of the recording, and all participants will be muted upon entering the meeting. **Be aware that you might be recorded when asking a question during the lecture.** If you feel uncomfortable with this, please use the chat or ask your question in the discussion part of the lecture, during which recording will be turned off. To ask a question, please raise your hand using the button "Raise Hand" ("Hand heben").
- No need to take your own recordings – please refrain from doing so. It would in fact be against privacy laws of the presenters to record their voice or video without prior consent.

Materials and online teaching platforms of the respective institutions

Slides, problem sets, and other materials will be available through the respective digital teaching platform of your institution:

- **KIT:** ILIAS, <https://ilias.studium.kit.edu/>
- **RWTH:** RWTH Moodle, <https://moodle.rwth-aachen.de>
- **TUB and external participants:** Materials will be made accessible through "BWSync&Share" platform. For access, please write an email to picda@ipq.kit.edu.

Access to licenses from Ansys Lumerical:

Problem sets and design projects will rely on the commercial photonics simulation and design software Lumerical offered by Ansys Inc., Canonsburg, Pennsylvania (<https://www.ansys.com/de-de/products/photonics>). During the summer term, Lumerical education licenses for the course are available at KIT for all students enrolled at one of the participating universities (KIT, RWTH, TUB). There are 50 licenses available from 15. April until 05. August 2024.

Instructions for installation of the software and for accessing the license:

- Download the Lumerical software package from the Lumerical website (<https://www.lumerical.com/downloads/>) under "Customer downloads".
- After creating an account and installing the software, choose: "I have a license from Ansys".
- The license server address is provided to registered participants of the lecture. Please have a look at the material in the online teaching platform of your respective institution.

Note: The Lumerical license server/program does not work with Macs unfortunately. It should work with Windows and Linux.

Examination and grading for KIT and RWTH students

- **Part 1 – Solutions of problem sets:** We will grade your solutions of the various problem sets and design projects. To this end, please upload your solution via the online teaching platform of your respective institution (see above) **before the respective deadline**. Please merge all pages into a single pdf file, and please use a scanner. Snapshots made with smartphones are often illegible, and in this case your solutions cannot be evaluated. In case there are any technical difficulties with the platforms, you may also submit your solutions by e-mail to picda@ipq.kit.edu before the respective deadline.
- **Part 2 - Presentation of one pre-assigned problem set:** At the beginning of the term, design projects will be pre-assigned to groups of participants. Each of these groups will explain their approach and results to lecturers and peer students in a short presentation (approx. 15 min), followed by approx. 10 min of public discussion with peer students and professors.

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The presentation and public discussion of the pre-assigned design projects will be followed by individual private interviews of each group member (approx. 10 min per person), that will be counted towards the grade of Part 2. The solution, presentation, public discussion, and individual interview in Part 2 will result in a compound grade, which contributes 60 % towards the final grade of the course. The solutions of all other design projects and problem sets in Part 1 will be averaged and contribute the remaining 40 % of the final grade.

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The pass/fail decision for the laboratory part will be made based on the handed-in problem sets (60%) and the public presentation (40%). The final grade of the lecture part will be based on a 20-minute oral exam at the end of the semester. Admission to the exam is conditioned on the laboratory part having been completed.

Semester plan

The following plan might be subject to modifications, which will be announced in the lecture or in the tutorial and which will be indicated in the respective online teaching platform of our institution.

Mon, 15. April 2024: Lecture 1 <i>Introduction to silicon photonics</i> C. Koos, J. Witzens, L. Zimmermann	Thu, 18. April 2024: Tutorial 1 <i>Introduction to Lumerical</i> Y. Chen, A. Kotz, A. Mashayekh
Mon, 22. April 2024: Lecture 2 <i>Silicon photonics – technology overview</i> J. Witzens, L. Zimmermann	Thu, 25. April 2024: Lecture 3 <i>Integrated optical waveguides and mode calculation</i> C. Koos
Mon, 29. April 2024: Lecture 4 <i>Signal propagation and mode expansion</i> C. Koos	Thu, 02. May 2024: Tutorial 2 <i>Problem Set 1: Mode fields and mode expansion (Q&A)</i> H. Kholeif, A. Kotz, A. Mashayekh
Mon, 06. May 2024: Lecture 5 <i>Finite-difference time-domain (FDTD) technique and scattering matrices</i> C. Koos	Thu, 09. May 2024: No lecture (Ascension Day)
Mon, 13. May 2024: Lecture 6 <i>Selected passive devices</i> C. Koos	Thu, 16. May 2024: Lecture 7 <i>Modulators</i> J. Witzens
20. – 25. May 2024: No lectures (Pentecost)	
Mon, 27. May 2024: Lecture 8 <i>Photodetectors</i> L. Zimmermann	Thu, 30. May 2024: No lecture (Feast of Corpus Christi)
Mon, 03. June 2024: Lecture 9 <i>Optical amplifiers and lasers</i> J. Witzens	Thu, 06. June 2024: Tutorial 3 <i>Introduction to Lumerical Scripting</i> Y. Chen, A. Kotz, A. Mashayekh
Mon, 10. June 2024: Lecture 10 <i>Test and packaging</i> J. Witzens	Thu, 13. June 2024: Tutorial 4 <i>Problem Set 2: Multi-mode interference (MMI) coupler (Q&A)</i> H. Kholeif, A. Kotz, A. Mashayekh
Mon, 17. June 2024: Lecture 11 <i>Optical communications</i> S. Randel	Thu, 20. June 2024: Tutorial 5 <i>Problem Set 3: Directional coupler (Q&A)</i> A. Schwarzenberger, A. Kotz, A. Mashayekh
Mon, 24. June 2024: Lecture 12 <i>Optical sensing and metrology</i> W. Freude	Thu, 27. June 2024: Tutorial 6 <i>Design Project A (Q&A 1 - Concepts)</i> A. Kotz, A. Schwarzenberger, A. Mashayekh
Mon, 01. July 2024: Lecture 13 <i>Biophotonics</i> A. Mashayekh	Thu, 04. July 2024: Tutorial 7 <i>Design Project B (Q&A 1 - Concepts)</i> A. Mashayekh, A. Schwarzenberger, A. Kotz
Mon, 08. July 2024: Tutorial 8 <i>Design Project A (Q&A 2 - Implementation)</i> A. Kotz, A. Schwarzenberger, A. Mashayekh	Thu, 11. July 2024: Tutorial 9 <i>Design Project B (Q&A 2 - Implementation)</i> A. Mashayekh, A. Schwarzenberger, A. Kotz

Mon, 15. July 2024: Lecture 14 <i>The future of optical communications is massively parallel (and non-quantum)</i> Peter Winzer, Nubis Inc. (Guest lecture)	Thu, 18. July 2024: Tutorial 10* <i>Design Project A (Presentations)</i> A. Kotz, A. Schwarzenberger, A. Mashayekh
Mon, 22. July 2024: Tutorial 11* <i>Design Project B (Presentations)</i> A. Mashayekh, A. Schwarzenberger, A. Kotz	Thu, 25. July 2024: Lab Tour

* These tutorials will be accompanied by short interviews at KIT, see Section "Examination and grading" above. For the presenting groups, these tutorials will be held in hybrid format in Building 30.10, Room 3.42 at KIT.