

Laser microfabrication , 2.0 credits

Lasermikrotillverkning , 2.0 hp

Third-cycle education course

6FITN74

Department of Science and Technology

Valid from: First half-year 2026

Approved by
The Board of PhD Studies

Approved
2025-11-03

Registration number

Entry requirements

Admitted to studies at postgraduate level

Learning outcomes

This course is designed for students from diverse academic backgrounds. By the end of the course students will be able to:

- Explain the capabilities of laser micromachining and the operation of different laser systems
- Understand interaction of laser with different materials and how it influences micromachining
- Describe components and basic operation of laser micromachining systems
- Identify suitable laser sources and techniques for specific applications and evaluate opportunities to integrate micromachining into their own research.
- Apply principles of laser safety.
- Gain direct experience with laser micromachining through hands-on sessions

Contents

1. Introduction to Lasers and Laser–Matter Interaction

- Basic laser concepts: generation, properties of laser light.
- Physics of laser–material interactions.

2. Laser Systems for Micromachining

- Overview of different laser types: principles of operation, comparisons, and trade-offs.
- Optical components, beam delivery, and system construction.

3. Laser–Material Interactions in Detail

- Absorption mechanisms in materials
- Nonlinear light–matter interactions.
- Material responses: heat transport (localized heating, heat affected zone), ablation, physical and chemical modifications (polymerization, bond breaking).

4. Femtosecond Lasers and Ultrafast Micromachining

- Motivation: why femtosecond lasers?
- Generation and processing of ultra-short laser pulses, laser parameters, and system trade-offs.
- Physics of ultrashort pulses and nonlinear processes at femtosecond timescales.

5. Applications of Laser Micromachining

- Micro- and nanofabrication using laser ablation.
- 3D direct writing and laser-assisted etching.
- Two-photon/multiphoton polymerization (additive manufacturing).
- Applications in biology and biomedical research.
- Case studies from industry and academia.

6. Practical Considerations

- Choosing laser systems for specific applications.
- Cost–capability trade-offs.
- Recent advances and future directions.
- Laser safety.

7. **Laboratory Sessions (Campus Norrköping, Laboratory of Organic **

- Hands-on session with a UV-laser ablation tool.
- Instructor led demonstration session using a femtosecond laser micromachining system

Educational methods

This PhD course will be taught in person at the Norrköping campus. Upon reasonable request, the lectures can be broadcasted online. The course consists of 6 lectures, 1 discussion/recap lecture, practical sessions (including a demo/lab tour and a hands-on session), and a final written examination. Each lecture will be 2 hours long. The demo and hands-on sessions will be approximately 4 hours each with the hands-on session carried out in small groups (spread over multiple sessions if necessary). The full course will span 10 weeks. The 6 lectures will be given on a weekly basis, the demo and hands-on sessions will be planned approximately after lecture 3 and 5 respectively. The lectures will be finalized with discussion/recap lecture (week 9). The written exam will follow the week after (week 10).

Examination

Written Examination

Grading

Two-grade scale

Course literature

Lecture notes and relevant literature will be provided during the course.

General information

Lectures: 14 h

Practicum: 8 h

Recommended study and examination: 34 h