

# Course ELEC-E8115 - Micro- and Nanorobotics D

## The number of credits:

5 ECTs

## Duration:

Period III and IV, 10.01.2025-15.03.2025. Lecture: 10.01.2025 – 14.02.2025.

## Learning outcomes:

After completing the course, a student can

1. explain the working principle of typical miniaturized robotic systems for different applications;
2. understand the physics of micro- and nano-scale locomotion and interaction;
3. describe the fabrication, actuation, and sensing techniques in miniaturized robotics;
4. apply robotic micro- and nano-manipulation systems for certain case studies;
5. program and control specific miniaturized robotic systems and
6. analyze and evaluate specific miniaturized robotic implementations.

## Content:

This course teaches miniaturised robotics, or micro- and nanorobotics, an interdisciplinary topic on small-scale robots working with microscopic objects or robots with miniaturized bodies. The content includes physics at micro- and nano scales, fabrication methods, sensing and actuation, manipulation at micro- and nano-scales, mobile microrobots, and selected examples of bio-manipulation, microassembly, miniaturized medical robots, miniature robotic scientific instruments, etc. Hands-on projects will be offered to student groups for in-depth study. This is an advanced course, so proactive actions from students are encouraged.

## Prerequisites:

Basic programming skills; basic course in automation.

## Course Homepage:

<https://mycourses.aalto.fi/course/view.php?id=43517>

## Teaching language:

English.

## Teacher in charge:

Quan Zhou

## Contact information:

Responsible teacher: Prof. Quan Zhou, [quan.zhou@aalto.fi](mailto:quan.zhou@aalto.fi)

Other teachers/assistants:

M.Sc. Artur Kopitca, [artur.kopitca@aalto.fi](mailto:artur.kopitca@aalto.fi)

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## Assessment Methods and Criteria

The course will be evaluated by home exercises and hands-on projects.

- **Home assignments (12 points total):** 4 home assignments, 3 points/assignment, effort-based. The assignment will be published on Wednesday, and a tutorial and Q&A session on the assignment will be part of Friday's lecture, with the submission deadline next Wednesday evening.
- **Hands-on projects (17 points total):** Two guided hands-on projects will be provided: one on robotic micromanipulation, the other on mobile microrobot. The hands-on projects include pre-exercises, supervised hands-on sessions, and reports. The hands-on projects should be carried out in groups. Group size: 3 students/group. The hands-on sessions may be replaced by a literature review under special circumstances, by agreement of the responsible teacher.
- **Final feedback on the course (1 point)**

The final grade will be given based on your total points: [50%, 60%) → 1, [60, 70%) → 2, [70%, 80%) → 3, [80%, 90%) → 4, [90%, inf] → 5.

The evaluation criteria will be clarified/revised in the first lecture.

### Workload

- Lectures and home assignments: contact hours: 20 h, independent study: 60 h for both review of lecture materials and further readings of lecture-related materials, and do the assignments.
- Hands-on exercises: contact sessions: 4-6 h, preparation, and reporting: 40 h.

### Study Material

- Handouts/ lecture slides. The main course materials are the lecture handouts (in the Materials section). The additional readings of each lecture will be given at the end of each lecture.

### Further Information

- The lectures will be held on the campus, in classroom M1 - M232, Kandidaattikeskus on Wednesdays, and 1501 Sklodowska-Curie at the Kide building on Fridays.
- The hands-on sessions will be organized on campus, room number to be informed later.
- Possible changes in course arrangement will be upon further notice.
- The first lecture will be held on Friday, January 10, 2025, at 12:15.

### Schedule

Remark: the schedule is tentative and subject to changes.

Course week	Date	Content	Place	Remark
W1	08.01.2025	-		
	10.01.2025	Introduction	1501	
W2	15.01.2025	Scaling and physics	M1 - M232	Home assignment 1
	17.01.2025	Fabrication methods	1501	+ tutorial and Q&A session
W3	22.01.2025	Actuation methods I	M1 - M232	Home assignment 2
	24.01.2025	Actuation methods II	1501	+ tutorial and Q&A session
W4	29.01.2025	Manipulation and mobile microrobots/agents I	M1 - M232	Home assignment 3
	31.01.2025	Manipulation and mobile microrobots/agents II	1501	+ tutorial and Q&A session
W5	05.02.2025	Sensing, control, and intelligence I	M1 - M232	Home assignment 4
	07.02.2025	Sensing, control, and intelligence II	1501	+ tutorial and Q&A session
W6	12.02.2025	Introduction to hands-on projects	M1 - M232	
	14.02.2025	Tutorial session for hands-on projects	1501	
	24-28.02.2025	Hands-on projects		The pre-exercises must be done before the actual hands-on sessions.
W10	15.03.2025	Deadline for the hands-on project reports		