Module Description, available in: EN

Optical engineering and metrology

General Information

Number of ECTS Credits

3

Module code

TSM_OpEngMe

Valid for academic year

2026-27

Last modification

2024-09-24

Coordinator of the module

Bojan Resan (FHNW, bojan.resan@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Optics: Basics of wave and geometrical optics;

Without optics basics during bachelor studies, the EVA “Fundamentals of light” should be visited before visiting further TSM modules.

Physics: Basics for engineers (bachelor niveau)

Brief course description of module objectives and content

The TSM module "Optical engineering and metrology" will provide the students with knowledge of numerous engineering and practical aspects of optical components, instruments, and metrology systems. Starting from seemingly simple optical components (mirrors, lenses, gratings, filters), the module covers high tech novelties on how to improve those components and bring them to the new level. Building up on those concepts, we will discuss more complex components, including acousto-optic, electro-optic, and liquid crystal modulators, as well as simpler systems like objectives and spectrometers. The module will be completed with methods applied in industry for measuring and diagnostics of various processes, including industrial interferometry, spectroscopy, imaging, and precise distance measurements.

Aims, content, methods

Learning objectives and competencies to be acquired

After successfully completing this module, the students should:

- understand the principles and know engineering aspects of basic optical components,
- be able to choose the appropriate optical element (including appropriate coating) for their tasks,
- know the principles of optical instruments and understand how some simple optical instruments operate,
- understand some optical metrology and microscopy methods, typically used in industry,
- be able to choose the appropriate optical diagnostics method for their process.

Module content with weighting of different components

1) Optical components (total 5 weeks):

- types of mirrors and lenses, incl. different coatings (1 week);
- principles of operation and types of polarization optics (waveplates, polarizer, isolator) (1 week);
- types, characteristics and applications of optical filters: absorption, interference, neutral density, reflective, long-pass, band-pass, notch, spatial, (1 week);
- gratings (1 week);
- light modulators (chopper, LCD, AOM, EOM) (1 week);

2) Optical instruments (total 3 weeks):

- Imaging optics (MTF, aberrations, camera objectives…) (1 week);
- Spectrometers (1 week);
- Colorimetry, color spaces and laser projection and displays (1 week);

3) Optical metrology (total 6 weeks):

- Industrial inspection: interferometry, industrial vision, Moire technique, laser triangulation (1.5 week);
- Spectroscopy: linear absorption, FTIR, luminescence, Raman (1 week);
- Hyperspectral imaging (1 week);
- Microscopy: confocal, two-photon, super-resolution STED, OCT (1.5 week);
- Laser detection: LIDAR, 3D sensing and self-driven cars (1 week);

Teaching and learning methods

Lectures, open discussion with students, self-study, seminar, and practical home work.

Literature

1) Lecturers' references to current literature,

2) Saleh, Tech: Fundamentals of optics

3) Hecht: Optics

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The seminar brings 5% to the final grade. The final grade is calculated as: final grade = 0.05 x seminar grade + 0.95 x final exam grade. Students can participate in the final exam without submitting the seminar.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral)

together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Personal formula collection: 4 A4 pages allowed.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted