Technology
Arts Sciences
TH Köln

Course
LMK - Light microscopy

Version: 1 | Last Change: 19.09.2019 15:08 | Draft: 0 | Status: vom verantwortlichen Dozent freigegeben

General information

Long name	Light microscopy
Approving CModule	LMK_BaET, LMK_BaET
Responsible	Prof. Dr. Stefan Altmeyer Professor Fakultät IME
Level	Bachelor
Semester in the year	winter semester
Duration	Semester
Hours in self-study	78
ECTS	5
Professors	Prof. Dr. Stefan Altmeyer Professor Fakultät IME
Requirements	mathematics; vector calculus complex numbers physics / optics: geometrical optics wave optics
Language	German
Separate final exam	Yes

Final exam

Details

As long as the number of participants is not too high, oral examination is preferred of written exams.

Lowest competence level checked is knowledge. This could be e.g. structural components that are present in every microcsope, the raypath of a transmission and a reflexion microscope with Köhler illumination, the location of the angular apertur and the phase ring in a Zernike phase microscope or the reason for the direction selectivity in a differential interference contrast microscope.

The next competence level is related to skills. Examination could be done by the calculation of required parameters of key components in a microscope, either on the basis of given application specifications or by the specification of some compontents, that are already in use. Furthermore it can be checked, if the setup of Köhler illumination can be explained, ideally with explanatory statements.

The highest competence level adressed is methodical expertise. It can be checked by the discussion of a real world task: E.g.: Determine the radius of curvature of a lens. Here the choice of the right type of microscope is already important. Furthermore the process of data ackquisition and the data manipulation good methodical expertise. Another task could be to measure quantitatively the relative phase shift of two structures in an object.

Minimum standard

Correct answer of at least 50 % of the questions

Exam Type

As long as the number of participants is not too high, oral examination is preferred of written exams.

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Lecture

Learning goals

Knowledge

depth of field
paraxial, on the object side
near and far point
hyperfocal distance
wace optical, on the image side

amplitude- and phase objects
law of Lamberr-Beer
optical density
phase, refraction index and optical distance
Abbe's theory of image formation
relative phase of diffraction orders

of amplitude objects
of phase objects

phase microscope
with phase disc
location and size of zero'th diffraction order
spatial coherence
diffraction artefacts
Zernike
location and size of zero'th diffraction order
spatial coherence
the priniciple of Babinet
diffraction artefacts
visibility and contrast
attenuation in the phase ring

coherence
visibility of interference
temporal coherence
lenght of wavetrains
spectral composition of wavetrains
time shifted arrival of amplitude split wavetrains
fast change of interference patterns
coherence time
spatial coherence
spatially split wavetrains
phase shift in spatially split wavetrains in dependence of the location of the origin
spatial overlay of interference patterns
spatial coherence length

interferometer
Michelson
compensation plate
second interference pattern
Mach-Zehnder
phase shifts on reflexions
complementary interference patterns
contrast of unequal splitted wavefronts
ambiguity of intereference patterns
white light interferometer
interference colors and contrast function

interference microscope
Linnik
sorted pairs of objectives
Michelson
long work distance objectives
Mirau
Schwarzschild objectives
differential interference contrast
birefringence
modification of Huygens' principle
indicatrix
Wollaston-, Nomarski- and Smith prisms
splitting below resolution
interference colors

base optical path difference and lambda plate

coherence requirements in the DIC

temporal

spatial

transmission-interference microscopes

Leitz' Mach-Zehnder interference microscope

interphaco microscope

Skills

calculate depth of field

convert optical density, dynamic in images and absorption coefficients into on another

determine phase discontinuities at interfaces quatitatively

calaculate sizes of phase rings and angular apertures of Zernike phase microscopes

calculate the strength of diffraction orders and derive image contrast from them

estimate temporal coherence from bandwith of frequencies and wavelengths and vice versa

estimate spatial coeherence from lightsource size and distance and vice versa

draw ray paths of the different interference micorscopes and explain them

calculate the requirements regarding coherence in the different interference microscopes

calculate geometries from ackquired interferograms

predict colors in white light interferometry

explain and compare physically and technically the underliying principles of different microscopes

Expenditure classroom teaching

Type	Attendance (h/Wk.)
Lecture	2
Tutorial (voluntary)	0

Separate exam

none

Practical training

Learning goals

Skills

set up Köhler illumination

balancing lengths and angles in interferometers

prepare objects for microscopy

set up, adjust and use microscopes, especially
bright field
dark field
reflexion
transmission
Zernike phase contrast
Linnik interference contrast
differential interference contrast

choose a suitable microscopy principle for a given object and task

tell artefacts from object details

judge image quality

write scientific report
describe the task
descirbe the idea of the solution
explain the experimental setup
explain the data processing
make error analysis
present the results and make a critical discussion

Expenditure classroom teaching

Type	Attendance (h/Wk.)
Practical training	2
Tutorial (voluntary)	0

Separate exam

Exam Type

working on projects assignment with your team e.g. in a lab)

Details

1) Written examination questions related to the experiment have to be prepared at home and shown at the beginning of the laboratory.

2) The underlying ideas of the experiment have to be explained at the beginning of the laboratory.

3) Make the experiment alone (preferred) or in a team of two.
- Build up and adjust your own setup
- Acquire / measure date with this setup

4) Write a documentation on the experiment. It will be checked wih regard to
- completness
- scientific and precise language
- correctness
- understanding of the interrellations and interpretation of the results

Minimum standard

All written tasks must have been delt with.

The basic ideas of the experiment must have been understood.

All experiments must have been performed.

The reports must be free of systematical errors.