Course guide
370008 - FOTOMINSTR - Photometry and Optical Instruments

Last modified: 20/03/2024

Unit in charge: Terrassa School of Optics and Optometry
Teaching unit: 731 - OO - Department of Optics and Optometry.

Degree: BACHELOR'S DEGREE IN OPTICS AND OPTOMETRY (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

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DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE04. (ENG) The ability to understand the process of image formation and the properties of optical systems. The ability to understand aberrations in optical systems. The ability to understand radiometric and photometric fundamentals and laws.
CE06. (ENG) The ability to recognise the eye as an optical system. The ability to understand the basic models of vision. The ability to understand ocular models and parameters.
CE07. (ENG) The ability to understand and manage basic laboratory materials and techniques.
CE09. (ENG) The ability to understand the principles, descriptions and characteristics of basic optical instruments and the instruments used in optometric and ophthalmic practice.
CE12. Understand and make use of techniques for analysing, measuring, correcting and monitoring the effects of compensatory optical systems on the visual system in order to optimise their design and fit. Make use of the techniques of centring, fitting, mounting and adjusting on all kinds of optometrically prescribed lenses, visual aids and protective eyewear. Prescribe, monitor and follow up with optical corrections. Identify and analyse environmental and workplace risk factors that could lead to visual issues.

Generical:
CG6. Assess and incorporate the technological improvements necessary to properly carry out professional activities.

CG8. Plan and carry out research projects that contribute to the production of knowledge in the field of optometry and disseminate this scientific knowledge via the typical communication channels.
CG9. Expand and update one’s professional abilities through continuing education.
CG16. Participate effectively in both single-discipline and multidisciplinary work groups on projects related to optometry.

Transversal:
CT3. Teamwork. To be able to work as a member of a multidisciplinary team, either as a base member or undertaking managerial decisions aiming at developing projects from a practical and responsible standpoint, adopting commitments given the available resources
CT6. Independent learning. Identify and overcome gaps in one's knowledge by thinking critically and choosing the best approach to extending one's knowledge.

TEACHING METHODOLOGY

MD1 - Participatory lecture on theory and problems.
MD3 - Practical problem-solving class requiring student participation in case studies and/or exercises on topics related to the subject matter.
MD4 - Laboratory practicals.
MD6 - Completing problems, exercises and assignments, and resolving doubts via the ATENEA virtual campus.

LEARNING OBJECTIVES OF THE SUBJECT

To understand the factors that determine the illumination and the field of an optical system.
To situate the corresponding conjugates of aperture and field diaphragms in the object space and image space.
To understand the limitations of paraxial optics.
To understand optical aberrations.
To understand photometric and radiometric magnitudes.
To calculate photometric and radiometric magnitudes.
To measure photometric and radiometric magnitudes.
To understand key optical instruments.
To determine conjugation and photometric relations in key optical instruments.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours medium group	45,0	30.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

Diaphragms

Description:
Field and aperture diaphragms.
Pupils. Entrance pupil and exit pupil.
Windows. Entrance window and exit window.
Linear and angular fields.
Aperture diaphragms and depth of focus.
Aperture diaphragms and depth of field.
Telecentric systems.

Specific objectives:
To understand the factors that determine the illumination and the field of an optical system.
To differentiate field diaphragms from aperture diaphragms.
To situate the corresponding conjugates of aperture and field diaphragms in the object space and image space.
To know how to properly reduce the field in an optical system.
To calculate the linear and angular fields in an optical system.
To recognise vignetting in an image.
To define the aperture number, the relative aperture and the diaphragm number.

Related activities:
PR1. Diaphragms, pupils and windows in optical systems consisting of two thin lenses.

Full-or-part-time: 9h
Theory classes: 5h
Laboratory classes: 4h

Optical aberrations

Description:
Ray and wave aberrations.
Seidel aberrations.
Spherical aberration.
Coma aberration
Astigmatism aberration.
Curvature of fiels aberration.
Distortion aberration.
Chromatic aberrations.
Aberrations and diaphragms
Aberrometers.
The Hartmann-Shack aberrometer.

Specific objectives:
Ray and wave aberrations.
Seidel aberrations.
Spherical aberration.
Comatic aberration.
Astigmatism aberration.
Field curvature aberration.
Distortion aberration.
Chromatic aberrations.
Aberrations and diaphragms.
Aberrometer.
The Hartmann-Shack aberrometer.

Full-or-part-time: 5h
Theory classes: 4h
Laboratory classes: 1h

Photometry

Description:
The spectrum of a source of light.
Radiometric magnitudes.
Energy.
Radiant flux.
Radiant intensity.
Irradiance.
Exitance.
Radiance.
Photopic and scotopic spectral sensitivity of the eye.
Photometric magnitudes.
Luminous flux.
Luminous intensity.
Illumination.
Luminous exitance.
Luminance.
Exposure.
Photometry of the optical image.
Luminous efficacy of a light source.
Attributes of a light source: the colour temperature and the colour rendering index.
LED sources.

Specific objectives:
To understand radiometric and photometric magnitudes.
To connect radiometric magnitudes with photometric ones.
To relate the main photometric magnitudes.
To properly interpret the photometric data of a light source.
To understand direction in perfect diffusers.
To calculate the illumination of an image in an optical system.
To understand the parameters that affect the illumination of an image.
To measure radiances and illumination.

Related activities:
PR1. Calculation of radiometric and photometric magnitudes from the power spectral density (PSD).
PR2. Photometric measurements (illumination and luminance) in the laboratory. Verification of the inverse-square law of distance in illumination.

Full-or-part-time: 16h
Theory classes: 12h
Laboratory classes: 4h

Objective optical instruments

Description:
The camera.
Main parts.
The objective.
The diaphragm.
The shutter.
The sensor.
Sensor sensitivity.
The light meter.
EXIF data.
The viewfinder.
Image magnification.
The image field.
The resolution.
The photometry of images.
Elements that make up photographic lenses.
The projection system.
Analogue and digital projection systems. Basic diagrams.

Specific objectives:
To differentiate objective optical instruments from subjective ones.
To schematise the photographic camera and its projection system.
To understand the elements that make up the photographic camera and its projection system.
To calculate the angular field of a photographic system.
To understand the parameters that determine the illumination of an image.
To understand image exposure.
To determine the depth of field of a photographic system.
To understand the elements that limit the resolution of a camera.
To calculate the resolution of a camera.
To understand the elements that make up the camera in a mobile phone.
To understand the basic diagrams of traditional illumination systems.

Related activities:
PR1. Photographic camera. Relating illumination and the diaphragm number. Measuring linear and angular fields. Relating depths of field and focus to diaphragm aperture.

Full-or-part-time: 16h
Theory classes: 12h
Laboratory classes: 4h

Subjective optical instruments

Description:
The reduced eye.
Visual augmentation.
Field and aperture diaphragms.
Resolution of the eye.
The magnifying glass or simple microscope.
Diagram.
Visual augmentation.
Field and aperture diaphragms.
Resolution.
Eye pieces.
Types of eye pieces.
The compound microscope.
Diagram.
Visual augmentation.
Field and aperture diaphragms.
Resolution.
Illumination system of a compound microscope.

Specific objectives:
To understand the limitations of the eye when an image is observed.
To understand visual augmentation.
To understand commercial augmentation.
To understand basic commercial magnifying glasses and eye pieces.
To schematise a microscope.
To schematise an astronomical telescope.
To understand the systems for inverting the image in an astronomical telescope.
To understand numerical aperture.
To calculate the linear object field in a microscope.
To calculate the angular object field in an astronomical telescope.
To understand the parameters that affect the luminosity of a microscope.
To understand the parameters that affect the luminosity of an astronomical telescope.
To understand the causes that limit resolution in the aforementioned instruments.
To calculate the linear resolution of a microscope.
To calculate the angular resolution of an astronomical telescope.

Related activities:
PR1. Measuring the field, visual magnification and resolution of a magnifying glass.
PR2. Measuring the linear object field and resolution of a microscope.

Full-or-part-time: 16h
Theory classes: 12h
Laboratory classes: 4h

ACTIVITIES

Laboratory practical on diaphragms

Description:
Observing the effect of aperture and field diaphragms in an optical system.

Delivery:
Report with the results obtained.

Full-or-part-time: 2h
Laboratory classes: 2h

Laboratory practical on photometry

Description:
Testing the law of squared distance.
Measuring the angular distribution of light in a plane.

Delivery:
Report with the results obtained

Full-or-part-time: 2h
Laboratory classes: 2h

Photometric calculations derived from the light spectrum

Description:
Calculating illumination from spectral irradiance data for different light spectra.

Delivery:
Report with the results obtained

Full-or-part-time: 2h
Laboratory classes: 2h

The magnifying glass

Description:
Characteristics of the magnifying glass. Augmentation, resolution and field.

Delivery:
Report with the results obtained

Full-or-part-time: 2h
Laboratory classes: 2h

The photographic camera

Description:
Parts of the photographic camera. Photometry, field and depth of field.

Delivery:
Report with the results obtained.

Full-or-part-time: 2h
Laboratory classes: 2h

The microscope

Description:
Characteristics of the microscope. Parts. Augmentation, resolution and field.

Delivery:
Report with the results obtained

Full-or-part-time: 2h
Laboratory classes: 2h

Astronomical telescope

Description:
Characteristics of the astronomical telescope. Parts. Augmentation, resolution and field.

Delivery:
Report with the results obtained

Full-or-part-time: 2h
Laboratory classes: 2h

name english

Description:
European Diploma competencies:
The Photometry and Optical Instruments course contributes fully or partially to Competency 1. Geometrical optics (9) ophthalmic and optical instruments, which is worked on in Topic 5, with a weight of 1 ECTS credit.
It also contributes fully or partially to Competency 5. Occupational optics (4) lamps and lighting, regulations on lighting, which are worked on in Topic 1, with a weight of 0.5 ECTS credits.
Assessment of the cross-disciplinary independent learning competency will be favourable if students complete all of the course's self-assessment tests, have attended 80% of practical sessions and have passed the subject with a final mark of 5 or greater.
The mark given for the cross-disciplinary independent learning competency will be the same the final mark received in the course.

Full-or-part-time: 1h
Self study: 1h

GRADING SYSTEM

Continuous assessment. No assessment may count for more than 50% of students' final marks.
Assessment takes into account all of the work done during the course.
Self-assessment tests, exercises, in-class participation on problems and cross-disciplinary competencies (P), laboratory work and reports (L), mid-semester exams (M) and a final exam (F).
The final mark (N) is obtained using the following formula: N = 0.10 P + 0.25 L + 0.30 M + 0.35 F
Students who fail the subject with a mark greater than or equal to 3 have the option to pass it by taking a resit examination.
This resit examination will be conducted under the conditions established by the Academic Regulations for Bachelor's and Master's Degrees at the UPC (NAGRAMA) and the specific conditions established by the Terrassa School of Optics and Optometry.
The resit examination will be carried out with a single exam that will be global of the entire subject. The exam topics will be theoretical only. Students who pass the resit exam are given a final mark of 5 in the course. Otherwise, they keep the highest mark they received between the previous assessment and the resit exam.

EXAMINATION RULES.

In case of partial or total copy of any evaluations of the course, will apply the provisions of General Academic Regulations
UPC: Irregular actions potentially leading to a significant variation of the marks obtained by one or more students will be considered a breach of the assessment regulations. Such behaviour will result in a descriptive mark of "Fail" and a numerical mark of 0 for the examination in question and the subject, without prejudice to any disciplinary proceedings that may result from that behaviour.
If a student disagrees with this decision, he or she may file a complaint with the dean or director of the school. If the student is not satisfied with the response, he or she may lodge an appeal with the rector.
If copying (either partial or total) is found to have taken place on any course assessment, that which is stipulated in the Academic Regulations for Bachelor's and Master's Degrees at the UPC will apply. Any kind of cheating on any exam will, at the least, result in a mark of 0 for that exam, and possibly in more severe disciplinary action.

"Irregular actions potentially leading to a significant variation of the marks obtained by one or more students will be considered a breach of the assessment regulations. Such behaviour will result in a descriptive mark of "Fail" and a numerical mark of 0 for the examination in question and for the subject, without prejudice to any disciplinary proceedings that may result from that behaviour.

If students disagree with this decision, they may file a complaint with the dean or director of the school. If students are not satisfied with the response, they may lodge an appeal with the rector.

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The director or dean of the school makes decisions regarding allegations about any aspects not covered in the regulations."

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- Greivenkamp, John E. Field guide to geometrical optics [on line]. Bellingham: SPIE Press, cop. 2004 [Consultation: 13/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=728500. ISBN 9780819452948.
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Complementary:
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RESOURCES

Other resources:
Optics laboratory:
- Optics material: optical benches, lenses, screens, sliders.
- Measuring instruments: photometers, goniometers.
- Optical instruments: magnifying glasses, microscopes, analog cameras.