Course guides
370008 - 370008 - Photometry and Optical Instruments

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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: 2020 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Jaume Escofet Soteras
https://futur.upc.edu/179614

Others: Elisabet Pérez Cabré
María Sagrario Millán García-Varela

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE04. (ENG) Conèixer el procés de foramció de imatges i propietats dels sistemes òptics. Conèixer les aberracions dels sistemes òptics. Conèixer els fonaments i lleis rediomètriques i fotomètriques.

CE06. (ENG) Reconèixer l'ull com a sistema òptic. Conèixer els models bàsics de visió. Conèixer els paràmetres i els models oculars.

CE07. (ENG) Conèixer i gestionar material i tècniques bàsiques de laboratori.

CE09. (ENG) Conèxier els principis, la descripció i característiques dels instruments òptics fonamentals, així com dels instruments que s'utilitzen en la pràctica optomètrica i oftalmològica.

CE12. (ENG) Conèixer i gestionar les tècniques per a l'anàlisi, mesura, correcció i control dels efectes dels sistemes òptics compensadors sobre el sistema visual, amb la finalitat d'optimitzar el disseny i l'adapaticó dels mateixos. Ser capaç de gestionar les tècniques de centrat, adaptació, muntatge i manipulació de tot tipus de lents, de una prescripció optomètrica, ajuda visual, ullera de protecció. Habilitat per a prescriure, controlar i fer el seguiment de les correccions òptiques. Identificar i analitzar els factors de risc medioambientals i laborals que poden causar problemes visuals.

Generical:
CG6. (ENG) Valorar i incorporar les millores tecnològiques necessaries par al correcte desenvolupament de la seva activitat professional.

CG8. (ENG) Ser capaç de planificar i realitzar projectes d'investigació que contribueixin a la producció de coneixements en l'àmbit de Optometria, transmitint el saber científic per el mitjans habituals.

CG9. (ENG) Ampliar i actualitzar les seves capacitats per a l'exercici professional mitjançant la formació continuada.

CG16. (ENG) Demostrar capacitat per participar de forma efectiva en grups de treball unidisciplinars i multidisciplinars en projectes relacionats amb l'optometria.

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. (ENG) Aprenentatge autònom. Detectar les diferències en el propi coneixement i superar-les mitjançant la reflexió crítica i la elecció de la millor actuació per ampliar aquest coneixement.

TEACHING METHODOLOGY

MD1 - Participatory exhibition class of theoretical and practical content
MD3 - Practical class of resolution, with the participation of the students, of practical cases and / or exercises related to the contents of the subject
MD4 - Laboratory practices
MD6 - Realization of problems, exercises, works and resolution of doubts through the virtual campus Atenea

LEARNING OBJECTIVES OF THE SUBJECT

Know the elements that determine the lighting and the field in an optical system.
Place the corresponding conjugates of the aperture and field diaphragms in the object and image spaces.
Know the limitations of paraxial optics.
Know the optical aberrations.
Know the photometric and radiometric magnitudes.
Calculate photometric and radiometric magnitudes.
Know the fundamental optical instruments.
Establish conjugation and photometric relationships with the fundamental 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

Stops

Description:
Aperture and field The pupils.
Entrance pupil and exit pupil.
Linear and angular fields.
Entrance window and exit window.
Aperture and depth of focus.
Aperture and depth of field.
Telecentric systems-

Specific objectives:
Understand the elements that determine the illumination and the field in an optical system.
Differentiate the opening diaphragm from the field.
Place the corresponding conjugates of the aperture and field diaphragms in the object and image spaces.
Know how to properly limit the field in an optical system.
Estimate the linear and angular fields in an optical system.
Look at the vignetting of an image.
Define the numerical aperture, the relative aperture and the diaphragm number.

Related activities:
PR1. Stops, pupils and windows in a system composed by two thin lens.

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:
To know optical aberrations.
To identify, qualitatively, monochromatic or Seidel aberrations.
To know the devices that measure eye aberrations.
Design thin lenses with minimal aberrations.
Qualitatively identify chromatic aberrations.
Minimize the chromatic aberrations of a simple system.

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

Photometry

Description:
The spectrum of the light source.
Radiometric magnitudes.
Energy.
Radiant flow.
Radiant intensity.
Irradiance.
Excitancy.
Radiance.
Photopic and scotopic spectral sensitivity of the eye.
Photometric magnitudes.
Light flux.
Light intensity.
Illuminance or lighting.
Light excitancy.
Luminance.
Exposure.
Optical image photometry.
Light performance from a light source.
Attributes of a light source: the color temperature and the color reproduction rate.
LED sources.

Specific objectives:
To know the photometric and radiometric quantities.
Relate the radiometric quantities to the photometric ones.
Relate the main photometric quantities.
Correctly interpret the lighting facts of a light source.
Know the directionality of the perfect diffusers.
Calculate the illumination of the image in an optical system.
Know the parameters that influence the lighting of the image.
Measure radiance and illumination.

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

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

Objective optical instruments

Description:
Photographic camera
Main constituent elements.
The lens.
The diaphragm.
The shutter.
The sensor.
Sensor sensitivity.
The exposure meter.
EXIF data.
The viewfinder.
The magnification of the image.
The image field.
The resolution.
The photometry of the image.
Elements that constitute the photographic objective
The projection system.
Analog and digital projection systems. Basic schemes.

Specific objectives:
Differentiate objective optical instruments from subjective ones.
Schematize the camera and projection system.
Know the elements that constitute the camera and the projection system.
Calculate the angular field in a photographic system.
Know the parameters that determine the lighting of the image.
Know image exposure.
Determination of the depth of field of a photographic system.
Know the elements that limit the resolution of the camera.
Calculate the resolution of the camera.
Know the elements that compose the smart phone camera. the basic schemes of traditional lighting systems.

Related activities:
PR1. Photographic camera. Illuminance-f stop relationship. Measurement of linear and angular fields. Relationship between depth of field and focus with aperture stop.

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

Subvective optical instruments

Description:
The reduced eye
Visual magnification.
Aperture and field diaphragms.
Eye resolution.
The magnifying glass or simple microscope.
Scheme.
Visual magnification.
Aperture and field diaphragms.
Resolution.
Eyepieces.
Types of eyepieces.
The compound microscope.
Scheme.
Visual magnification.
Aperture and field diaphragms.
Resolution.
Compound microscope lighting system.

Specific objectives:
Understand the limitations of the eye by observing an image.
Know the visual magnification.
Know the commercial magnification.
Know the basic commercial magnifiers and eyepieces.
Schematize a microscope.
Schematize a telescope.
Know the image inversion systems in a telescope.
Understand the numerical aperture.
Calculate the linear object field in a microscope.
Calculate the angular field object in a telescope.
Know the parameters that affect the luminosity of the microscope.
Know the parameters that affect the luminosity of the telescope.
Know the causes that limit the resolution in the previous instruments.
Calculate the linear resolution of the microscope.
Calculate the angular resolution of the telescope.

Related activities:
PR1. Measurement of the field, the visual magnification and the resolution in a telescope.
PR2. Measurement of the linear object field, visual magnification and resolution in a microscope.

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

ACTIVITIES

Lab work about diaphragms

Description:
Visualize the effect of opening and field diagrams on an optical system

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

Lab work about photometry

Description:
Checking the law of the square of distance.
Measure the angular distribution of light in a plane.

Delivery:
Report with the results obtained

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

Photometric calculus derived from the light spectrum

Description:
Calculate the illumination from the 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:
Magnifying glass features. Magnification, resolution and field.

Delivery:
Report with the results obtained

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

Photographic camera

Description:
Elements of the camera. Photometry, field and depth of field.

Delivery:
Report

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

The microscope

Description:
Microscope characteristics. Elements. Magnification, resolution and field.

Delivery:
Report with the results obtained

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

Telescopes

Description:
Telescope characteristics. Elements. Magnification, resolution and field

Delivery:
Report with the results obtained

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

GRADING SYSTEM

Continued avaluation. No test will exceed 50% of the final grade.
The evaluation will take into account all the work done during the course:
Self-learning tests-exercises-participation in problems class (P), work and
laboratory reports (L), partial exams (M) and a final exam (F).
The final grade (N) will be obtained with the formula:
N = 0.10P + 0.20 L + 0.40 M + 0.30 F
Competences of the European diploma:
The subject Photometry and Optical Instruments participates totally or partially in the competition 1.Geometrical optics (9) ophthalmic and optical instruments that is worked to the content of the subject 5 with a weight of 1 ECTS.
It also participates in whole or in part in 5.Occupational Optics (4) lamps and lighting, lighting regulations which is worked on in topic 1 with a weight of 0.5 credits.

EXAMINATION RULES.

In all the tests the students will be able to have a sheet with formulas
Fraudulent actions in the evaluation tests will be sanctioned according to section 3.1.2 of the Academic Regulations of Degrees and Masters of the UPC.

BIBLIOGRAPHY

Basic:
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- Pedrotti, Frank L; Pedrotti, Leno M; Pedrotti, Leno S. Introduction to optics . Third edition [re-issued]. Cambridge, United Kingdom ; New York, NY : Cambridge University Press, 2018. ISBN 978-1-108-42826-2.
- Millán García-Varela, M. Sagrario; Escofet Soteras, Jaume; Pérez Cabré, Elisabet. Óptica geométrica . Barcelona : Ariel, DL 2004. ISBN 84-344-8064-6.
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Complementary:
- Tkaczyk, Tomasz S. Field guide to microscopy . Bellingham : SPIE, cop. 2010. ISBN 9780819472465.
- Dettwiller, Luc. Les Instruments d'optique : étude théorique, expérimentale et pratique . Paris : Ellipses, cop. 1997. ISBN 2-7298-5701-X.
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- Allen, Elizabeth; Triantaphillidou, Sophie. The Manual of photography . Tenth edition. Burlington, MA : Focal Press, 2009. ISBN 978-0-240-52037-7.
- Christoph U. Keller; Ramón Navarro; Bernhard R. Brandl. Field Guide to Astronomical Instrumentation. SPIE PRESS BOOK, 2015.
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- Schwiegerling, Jim. Field guide to visual and ophthalmic optics . Bellingham, Washington : SPIE Press, cop. 2004. ISBN

9780819456298.
- Walker, Bruce H. Optical engineering fundamentals . New York [etc.] : McGraw-Hill, cop. 1995. ISBN 0-07-067930-4.
- Yoder, Paul R; Vukobratovich, Daniel. Field guide to binoculars and scopes . Bellingham : SPIE Press, cop. 2011. ISBN 9780819486493.
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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, photographic analogue cameras.