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370504 - OPTIGEO - Geometrical and Instrumental Optics

Coordinating unit: 370 - FOOT - Terrassa School of Optics and Optometry
Teaching unit: 731 - OO - Department of Optics and Optometry
Academic year: 2019
Degree: BACHELOR'S DEGREE IN OPTICS AND OPTOMETRY (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 9 Teaching languages: Catalan

Teaching staff

Coordinator: ELISABET PÉREZ CABRÉ (http://futur.upc.edu/ElisabetPerezCabre)

Others: JAUME ESCOFET SOTERAS (http://futur.upc.edu/JaumeEscofetSoteras)
MARIA SAGRARIO MILLÁN GARCÍA-VARELA (http://futur.upc.edu/MariaSagrarioMillanGarciaVarela)
Armengol Cebrian, Jesus

Degree competences to which the subject contributes

Specific:

2. Understanding the physical basis of the behavior of fluids and the nature, generation and propagation of light, to understand their role in their own processes and applications of optics and optometry.
3. Determine, according to the visual limitations, optical aids for each case.

8. Being able to take, treat, represent and interpret experimental data. "Use basic laboratory equipment and techniques"
1. Understanding the mechanism of imaging and information processing in the visual system.

Generical:

12. Develop methods to encourage teamwork participation of its members, critical thinking, mutual respect, the ability to negotiate to achieve common goals
13. Display information orally and in writing of reasonably and coherent.

14. Extract the main points of a text or any source of information (oral or written)

15. Synthesize and organize information to convey it effectively orally and / or written

16. Assessing the acquisition of the course objectives.

Teaching methodology

Theory classes respond to the traditional model of lecturing.
The classes of problems will be participatory and in groups.
Laboratory classes will be made in the laboratory of Geometrical Optics in groups of two/three students.

Learning objectives of the subject

The OVERALL OBJECTIVE of the course can be described as:
Study of the properties of the light. Set the geometric model to explain the propagation of light. Know the laws of geometrical optics. Describe the different elements of the optical system (diopters, mirrors, lenses and diaphragms). Apply the geometric model to explain the light paths and the formation of images in paraxial approximation. Knowing the

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optical aberrations. Correcting the most easier aberrations. Know the photometric and radiometric quantities. Learn simple optical instruments (lenses, eyepieces, camera lenses and projection systems) and optical instruments compounds (glasses and microscopes). Describe from the point of the paraxial approximation how the images are formed and the photometry in these instruments.

At the end of Geometrical and instrumental Optics course, students must achieve the following OBJECTIVES (taken from the BOE):
- Understand the imaging process and properties of optical systems.
- Understand and manage material and basic laboratory techniques.
- Learn about the propagation of light in isotropic media.
- Know the principles, description and characteristics of the fundamental optical instruments.
- Understand and calculate the geometric and optical parameters that characterize the different types of lenses.
- Training for calculating the geometrical parameters of the specific visual compensation systems: low vision, intraocular lenses, contact lenses and ophthalmic lenses.
- Know the aberrations of optical systems.
- Learn the basics and radiometric and photometric laws.
- Knowing the parameters and eye models.

And the SPECIFIC OBJECTIVES:
- To know a brief history of optics.
- Knowing the paradigms that make up the different models explaining the behavior of light.
- List and apply the laws that form the theoretical basis of geometrical optics.
- Interpret the meaning of the refractive index of a medium.
- Relate the wave surface and the rays of light.
- Describe and justify the phenomenon of dispersion.
- Explain the formation of the image of a point and an extended object.
- Describe the properties of a stigmatic.
- List the conditions for an optical system is considered perfect.
- Identify the combinations of prisms to reduce the spread or deviation.
- To know the total reflection prism.
- Explain the effects on investment and the displacement produced by the prisms in the images.
- Define increases lateral, angular and axial optical system.
- Determine the cardinal elements of an optical system.
- Apply the equations of correspondence in an optical system.
- Recognize and distinguish between different types of diaphragms.
- Indicate the limitations of the paraxial approximation.
- Name and identify, qualitatively, monochromatic aberrations or Seidel.
- Identify, qualitatively, chromatic aberrations.
- Explain, qualitatively, the mechanisms for correcting optical aberrations.
- Know the main photometric magnitudes and relations between them.
- To interpret the curves of light intensity of a source of light.
- Know basic optical instruments. Describe the correct imaging and photometry of optical instruments.

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Study load

Total learning time: 221h	Hours large group:	0h	0.00%
	Hours medium group:	63h	28.51%
	Hours small group:	27h	12.22%
	Guided activities:	5h	2.26%
	Self study:	126h	57.01%

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Content

1. Foundations of geometrical optics

Learning time: 52h

Practical classes: 16h
Laboratory classes: 6h
Self study : 30h

Description:
1. Brief history of optics
2. Paradigm Optics
3. Geometrical optics. fundamental Laws
4. Light scattering
5. Fermat's principle.

Related activities:
Labs:
1. Getting beams of light and dark chamber
2. Determination of the limiting angle. total reflection
3. Dispersing prism. Measurement of the refractive index of prism

2. Image: optical representation of the object

Learning time: 14h

Practical classes: 2h
Laboratory classes: 4h
Self study : 8h

Description:
1. Optical representation. Perfect imaging optical focusing systems
2. Astigmatic surfaces for two conjugate points
3. Paraxial optics: approximate astigmatism

Related activities:
Labs:
1. Plot of dioptric rays in different media and catoptrics

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3. The optical surface and their combinations

Learning time: 61h

Practical classes: 19h
Laboratory classes: 6h
Self study : 36h

Description:

1. Plane mirrors
2. Plane dioptria and plane-parallel plate.
3. Prisms
4. Diopters and spherical mirrors
5. The spherical surface paraxial optics
6. The thin lens

Related activities:

Labs:

1. Plane mirrors. kaleidoscopes
2. Focometría in lenses
3. Focometría mirrors

4. Paraxial characterization of image-forming systems.

Learning time: 16h

Practical classes: 4h
Laboratory classes: 2h
Self study : 10h

Description:

1. Cardinal elements of an optical system
2. General equations of correspondence
3. Association focusing optics
4. The thick lens
5. Specific formulation for the eye

Related activities:

1. Determination of cardinal elements in optical systems

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5. Real optical systems

Learning time: 23h

Practical classes: 6h
Laboratory classes: 4h
Self study : 13h

Description:

1. Diaphragms. Limiting aperture and field
2. Monochromatic Aberrations I : spherical, astigmatism and coma
3. Monochromatic Aberrations II: field curvature, distortion
4. Chromatic aberrations
5. Achromatic doublets

Related activities:

Labs:

1. Diaphragms
2. Aberrations

6. Photometry

Learning time: 14h

Practical classes: 4h
Laboratory classes: 2h
Self study : 8h

Description:

1. Visible spectrum and electromagnetic radiation
2. Radiometry
3. Photometry

Related activities:

Labs:

1. Photometry

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7. Optics instruments	Learning time: 36h Practical classes: 11h Laboratory classes: 4h Self study : 21h

Description:
1. Photographic and projection tools
2. Vision devices I: eye, lens and eye
3. Vision devices II : binoculars, telescopes, microscopes

Related activities:
Labs:
1. The photographic lens
2. The microscope

Qualification system

Assessment will be through: self-tests, class participation exercises of problems (Q); work, lab reports and exams (L), a partial exam (P) and a final exam (F).

The final grade (N) is obtained using the formula:

N = 0.10 Q + 0.20 L + 0.30 M + 0.40 F.

In case of total or partial copy in any assessments of the course shall apply to prevent the General Academic Regulations UPC: fraudulently perform any act of evaluation implies a minimum qualification of 0 in the act of evaluation and possibly more severe disciplinary proceedings.

Reassessment of Geometrical Optics and Optical Instruments will be taken according to general rules established in the “Normativa general de Graus i Màsters de la UPC” and to particular rules form the “Facultat d ’ Òptica i Optometria de Terrassa”. It will be a single final exam covering all the subjects of the course.

A final grade of 5 will be awarded to students passing this exam, otherwise the previous grade will remain.

Regulations for carrying out activities

- If there is not done any laboratory activities or continuous assessment, it will be scored with 0.
- Failure to attend two or more lab sessions will not pass the assessment for the works and reports of laboratory (L).
- Teachers will provide you a formulary in the partial and final tests.

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Bibliography

Basic:

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Pedrotti, Frank L, et al.. Introduction to optics. 3rd ed. San Francisco: Pearson Prentice-Hall, 2017. ISBN 9781108428262.

Meyer-Arendt, Jurgen R. Introduction to classical and modern optics. 3rd ed. Englewood Cliffs: Prentice-Hall International, 1989. ISBN 013479155X.

Hecht, Eugene. Óptica. 3a ed. Madrid: Addison-Wesley Iberoamericana, 2000. ISBN 8478290257.

Ditteon, Richard. Modern geometrical optics. New York: Wiley, 1998. ISBN 0471169226.

Mejías Arias, Pedro M. Optica geométrica. Madrid: Síntesis, 1999. ISBN 8477386358.

María Viñas, et al.. Descubriendo la luz: experimentos divertidos de óptica. 1a. Madrid: Consejo Superior de Investigaciones Científicas; Los libros de la Catarata , 2018. ISBN 978-84-00-10397-2.

Complementary:

Freeman, M. H. Optics. 10th ed. Oxford: Butterworth Heinemann, 1990. ISBN 0750622105.

Keating, Michael P. Geometric, physical and visual optics. 2nd ed. Boston: Butterworths-Heinemann, 2002. ISBN 9780750672627.

Schwartz, Steven H. Geometrical and visual optics: a clinical introduction. New York: McGraw-Hill, 2002. ISBN 0071374159.

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Hernández, Consuelo [et al.]. Un any de problemes d'òptica geomètrica. San Vicente del Raspeig: Universidad de Alicante, 2003. ISBN 8479087625.

Yoder, P.R.; Vukobratovich, D. Field guide to binoculars and scopes. Bellingham: SPIE Press, cop. 2011. ISBN 0819486493.

Tkaczyk, Tomasz S. Field guide to microscopy. Bellingham: SPIE, cop. 2010. ISBN 9780819472465.

Grant, Barbara G. Field guide to radiometry. Bellingham: SPIE, 2011. ISBN 9780819488275.

Others resources: