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370506 - OPTIFIS - Wave 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: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: FIDEL VEGA LERIN (http://futur.upc.edu/FidelVegaLerin)

Degree competences to which the subject contributes

Specific:

1. Technical english applied to optics and optometry

2. Understanding the mechanism of imaging and information processing in the visual system.

3. 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.

4. Determine the optical parameters of contact lenses in relation to the functionality of the visual system.

5. Determine, according to the visual limitations, optical aids for each case.

6. Do the control of quality of the glasses or optical aids made once the assembly.

7. Making use of machinery, instruments and tools needed to make assembly, adjustments, repairs and quality control of finished product.

8. Interpret refractive test results to determine the suitable optical prescription.

9. Being able to take, treat, represent and interpret experimental data. "Use basic laboratory equipment and techniques"

10. Evaluate the process of formation of the optical image in the retina and the transmission and information processing in the brain

Generical:

11. Develop methods to encourage teamwork participation of its members, critical thinking, mutual respect, the ability to negotiate to achieve common goals

12. Display information orally and in writing of reasonably and coherent.

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

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

15. Assessing the acquisition of the course objectives.

Teaching methodology

In this course we propose to combine theory sessions with informal lectures of cooperative learning activities, and for the lab work in small groups.

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Learning objectives of the subject

The course is based on geometrical optics, electromagnetic and quantum for the study of light phenomena related to the nature of light, its production, propagation and interaction with matter.
At the end of the course Wave optics, the student must have achieved the objectives (taken from BOE):
- Understand and handle basic laboratory equipment and techniques
- Understand the propagation of light in isotropic media, the light-matter interaction, interference, light diffraction phenomena, the properties of surface monolayers and multilayers and the principles of lasers and their applications.
- Understand the principles, description and basic characteristics of optical instruments and instruments used in ophthalmic and optometric practice.
- Learn the basics of radiometric and photometric laws.
- Understand the factors that limit the quality of the retinal image.

Study load

Total learning time: 144h	Hours large group:	0h	0.00%
	Hours medium group:	32h	22.22%
	Hours small group:	28h	19.44%
	Guided activities:	0h	0.00%
	Self study:	84h	58.33%

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Content

1. Light is an electromagnetic wave.	Learning time: 20h Theory classes: 0h Practical classes: 4h Laboratory classes: 2h Guided activities: 2h Self study : 12h

Description:
1.1 Brief review of waves. Plane waves in isotropic dielectric media.
1.2 Electromagnetic waves.
1.3-energy electromagnetic waves.
1.4-propagation of light in vacuum and in dielectric media

Related activities:
Laboratory:
0 .- Practice Introductory session.

Specific objectives:
Objectives: To light a wave e.m. cross.
- Define the following parameters (with their units): amplitude, wavelength, frequency and timing, speed, initial phase, characteristics of a wave I
- Determine the directions of propagation and vibration fields E and B comprising the light and the relationship between their amplitudes.
- Write the correct equation of E and B fields that make up a light wave (with its module and direction of vibration and propagation).
- Calculate the irradiance of a wave and its relationship with the radiant flux (power).
- Identify the order of magnitude of the wavelength of visible light.

2. Propagation of light in dielectric media and isotropic.	Learning time: 25h Theory classes: 0h Practical classes: 5h Laboratory classes: 7h Guided activities: 1h Self study : 12h

Description:
2.1 Reflection and refraction of light in meters d. i. Fresnel equations.
2.2-reflectance and transmittance.

Related activities:
Laboratory:
Practice 1 .- Measurement of R and T
Practice 2 .- Measurement of R / / and T / /. Brewster angle.
Practice 3 .- Measurement of R / / T and / / in a metal.

Specific objectives:
R & T Goals:
- Differentiate the external reflection of the internal.
- Define the plane of incidence.
- Determine if I light vibrates parallel or perpendicular to the plane of incidence.
- Understand the definition and formulas to explain the reflectance and transmittance perpendicular and parallel to the plane of incidence.
- Describe the curves of R and T depending on how about (in case of External and Internal Reflection).
- Define the Brewster angle and the conditions for it.
- Learn how to obtain the reflectance and transmittance of natural light.
- Justifying the need for treatments to slow antirreflexants.

3. Propagation of light in anisotropic dielectric media. Polarization of light.	Learning time: 35h Theory classes: 0h Practical classes: 7h Laboratory classes: 7h Guided activities: 1h Self study : 20h

Description:

3.1-What studies the polarization?
3.2-Type polarization:
3.3-What is a polarizer?
3.4-polarized wave equations.
3.5-linear polarizers. Ways to obtain linear polarized light:
3.6-retardant sheets.
3.7-Applications of the polarization (in the studio fotoelasticitat optics, 3D vision, filters ...)

Related activities:

Laboratory:
Practice 4 .- Law of Malus.
Practice 5 .- Print retardant Pi / 2.
Practice 6 .- retardant sheet Pi / 4.

Specific objectives:

Polarization Objectives:
- Explain exactly what is polarized light in comparison with natural light.
- Express any polarized light as a sum of two plane waves, harmonic and orthogonal to the relative amplitudes and desfàs correct.
- Explain the four processes for linear polarized light from natural light. Know how to calculate the state of polarization and the irradiance resulting from a wave systems in two and three linear polarizers.
- Explain the working principle of the retardant sheeting. Find the state of polarization of light through polarizing plates and retarders.
- Find and explain applications of polarized light in other areas and subjects of the Degree

4. Interference with light waves.	Learning time: 35h Theory classes: 0h Practical classes: 7h Laboratory classes: 7h Guided activities: 1h Self study : 20h

Description:
4.1-Principle of superposition. Difference wave-particle.
- Calculation of the intensity resulting in two overlapping waves:
- Conditions to see interference
4.2-interferometers by wavefront division.
- Young's double slit:
- Figure from interference with white light. Justification.
4.2-interferometer by amplitude division:
Interferometer Michelson - Morley:
Dielectric films.
4.3-and multilayer coatings. Different effects on optical and ophthalmic optics.

Related activities:
Laboratory:
Practice 7 .- Young's double slit.
Practice 8 .- Biprisma Fresnel.
Practice 9 .- Interference in thin layers.

Specific objectives:
Interference Objectives:
- Peat type of interference between two waves from the phase difference. Interference term.
- Explain the conditions (consistency, the same frequency ...) for which two waves interfere.
- Determine from the interfranja ¿y, the wavelength or the separation between gratings.
- Represent the from the grid in a double role desfàs.
- Explain the figure of a double-grid interference with both monochromatic light and white light.
- Explain the problem which is intended to prevent / solve with a sheet or anti superreflexant.
- Find the phase difference in the case of thin close to normal incidence (q »0).
- Define how the index should be on the sheet that covers the glass to take effect Antirreflexant / Superreflexant.
- Get the thickness of a thin layer from the top and / or minimum interference.
- Explain the dependence of the condition of interference with the wavelength.

5. Fraunhofer diffraction.	Learning time: 35h Theory classes: 0h Practical classes: 7h Laboratory classes: 7h Guided activities: 1h Self study : 20h

Description:
5.1 Fraunhofer diffraction from single apertures. A crack and a hole
- The principle of Huygens - Fresnel.
- Condition of Fraunhofer diffraction.
- Diffraction of a gap.
- Diffraction of an opaque barrier. Babinet's theorem.
- Diffraction from a circular opening.
- Rayleigh resolution criterion. Resolution limited by diffraction.
- What we would see if illegal luminéssim with white light?
5.2 Diffraction 2.3, ... N slits. The network of diffraction.
- Two holes. Figure diffraction & interference from two slits.
- The network of diffraction:
- Power resolution color.

Related activities:
Laboratory:
Practice 10 .- diffraction 1,2, ... N slits.
Practice 11 .- Red diffraction.
Practice 12 .- Diffraction from a circular opening.

Specific objectives:
Diffraction Goals:
- Describe the diffraction and phenomenological way of interpreting it according to the Huygens-Fresnel model.
- Describe the figures of the Fraunhofer diffraction curves and the associated openings of simple geometry (rectangular, double rack, network diffraction and circular opening).
- Distinguish difractius of interference phenomena in systems of multiple grids.
- Calculate the wavelength and the size of the openings from the figures of diffraction.
- Apply the Rayleigh resolution limit to determine when two points are determined by imaging optical systems trainers.

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Planning of activities

1. LABORATORY PRACTICES

Description:

All practices should be done in the laboratory will be in small groups and its duration is 2 hours. Students must come prepared to the session having the session. The laboratory should carry out the experimental part and a report of the practice.

Support materials:

All optical and mechanical equipment required for conducting the experiment is the laboratory.
Written details of the experiment. Software simulation.

Descriptions of the assignments due and their relation to the assessment:

Students prepare a report with the results of the experience made ¿¿in the lab and answer all the questions proposed in the script.
The student work and note all comments will be considered for qualification of the laboratory.

2. GUIDED ACTIVITIES

Hours: 6h
Guided activities: 6h

Description:

Performing in groups or individually, different exercises (problem solving, simulations, abstract,...).

Support materials:

Description of the activities on the intranet.

Descriptions of the assignments due and their relation to the assessment:

Students receive a report of each activity.
The student work and note all submissions will be considered for classification theory.

Qualification system

The evaluation will be based on continuous assessment.
The evaluation of the course is divided equally between the theory sessions (T) and laboratory (L).
The rating of theory (T) will be made from at least two tests. The laboratory rating will be based on at least two practice tests. No test will represent a weight of over 30% of the final mark.

The final (N) obtained by the formula:

$N = 0.5T + 0.5 L$

Regulations for carrying out activities

In case of partial or total copy of any evaluations of the course, will apply the provisions of General Academic Regulations UPC: perform any act of fraudulently assessment involves, at least a score of 0 in that self evaluation, and possibly more severe disciplinary processes.

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Bibliography

Basic:

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Pedrotti, Leno S. Optics and vision. Upper Saddle River: Prentice Hall, 1998. ISBN 0132422239.

Hewitt, Paul G. Física conceptual. 3a ed. México: Addison-Wesley Longman de México, 1999. ISBN 968444298X.

Mauldin, John H. Luz láser y óptica. Madrid: McGraw-Hill, 1992. ISBN 847615769X.

Tipler, Paul Allen; Mosca, Gene. Física per a la ciència i la tecnologia, vol. 1 [on line]. Barcelona [etc.]: Reverté, 2010 [Consultation: 03/10/2018]. Available on: <http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6536>. ISBN 9788429144321.

Tipler, Paul Allen; Mosca, Gene. Física per a la ciència i la tecnologia, vol. 2 [on line]. Barcelona [etc.]: Reverté, 2010 [Consultation: 03/10/2018]. Available on: <http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6537>. ISBN 9788429144338.

Complementary:

Hecht, Eugene. Óptica. México: McGraw-Hill, 1988. ISBN 9684222467.

Meyer-Arendt, Jurgen R. Introduction to classical and modern optics. 4th ed. Englewood Cliffs: Prentice-Hall International, 1995. ISBN 013124356X.

Carreño, Fernando. Óptica física : problemas y ejercicios resueltos. Madrid: Prentice Hall, 2001. ISBN 8420531812.

Óptica avanzada. Barcelona: Ariel, 2002. ISBN 8434480522.

Others resources: