Course guide
370010 - MATERIALS - Optical Materials

Last modified: 30/06/2025

Unit in charge: Terrassa School of Optics and Optometry
Teaching unit: 713 - EQ - Department of Chemical Engineering.

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

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

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PRIOR SKILLS

- Chemistry: formulation and elemental bases of inorganic and organic chemistry.
- Chemical and electrochemistry balance.
- Organic functions.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE05. (ENG) The ability to understand the structure of matter, the chemical processes of solutions and the structure, properties and reactivity of organic compounds. The ability to understand the composition and structure of the molecules that make up living beings. The ability to understand the transformation of certain biomolecules into others. The ability to study the molecular basis of the storage and expression of biological information. The ability to apply biochemical knowledge to the eye and the process of vision.

CE07. (ENG) The ability to understand and manage basic laboratory materials and techniques.
CE11. Describe the physical and chemical properties of the materials used in the field of optics and optometry.

CE23. Describe the properties of the types of contact lenses and ocular prostheses. Describe the geometry and physical-chemical properties of contact lenses and associate them with specific ocular and refractive characteristics. Identify and use clinical and instrumental protocols associated with fitting contact lenses. Identify the solutions used for maintenance, diagnosis and treatment and associate them with lenticular and ocular characteristics. Apply the clinical procedures associated with contact lens fitting to various refractive and ocular dysfunctions. Apply the controlled modification techniques of corneal topography with the use of contact lenses. Detect, assess and resolve abnormalities associated with the use of contact lenses. Adapt contact lenses and ocular prostheses to improve vision and the outer appearance of the eye.

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

CG11. Locate new information and interpret it in context.

CG12. (ENG) The ability to understand the general structure of optometry and its connection to other specific disciplines and other complementary ones.

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
CT7. Foreign language. Demonstrate knowledge of a foreign language, preferably English, at an oral and written level that is consistent with graduates' future needs.

TEACHING METHODOLOGY

MD01. Participative lecture of theoretical and practical contents.
MD03. Practical class of resolution, with the participation of the students, of practical cases and/or exercises related to the contents of the subject.
MD04. Laboratory practicals.
MD05. Reading of didactic material, texts and articles related to the contents of the subject.
MD06. Completion of problems, exercises and assignments, and resolution of doubts through the Atenea virtual campus.
MD07. Tutorials.

LEARNING OBJECTIVES OF THE SUBJECT

En acabar l'assignatura Materials Òptics, l'estudiant o estudianta ha de ser capaç de:

1. Utilitzar material i tècniques bàsiques de laboratori, i prendre, tractar, representar i interpretar dades experimentals.
2. Relacionar l'estructura amb les propietats dels compostos inorgànics, orgànics i biomolècules i les seves aplicacions com a materials òptics.
3. Conèixer les característiques dels materials emprats en la fabricació de lents oftàlmiques, lents de contacte i muntures per a ulleres.

This module contributes to the European Diploma in Optometry competencies indicated in the following link:
https://drive.google.com/drive/folders/1bwmHBsvkrGnY63DfXAnWZB_i0I2pXa-I?usp=drive_link

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

1. INORGANIC MATERIALS

Description:
First, the subject is presented, in which the students are told about the objectives of the subject and the program of the theory classes, application exercises and practices. The evaluation system is indicated and how communication between teachers and students will be carried out so that they obtain all the information about the subject.
In this content, the following topics are worked on:
Topic 1: Vitreous state.
- Definition and classification of mineral crystals.
- Composition and structure of oxide crystals.
- Vitrification.

Topic 2: Physical properties.
- Thermal properties and viscosity.
- Density.
- Optical properties. Absorption and transmission spectra.

Topic 3: Mechanical properties of inorganic glass.
- Elastic properties of glass.
- Mechanical resistance.

Topic 4: Chemical properties of inorganic glass.
- Chemical resistance. Attack mechanisms.
- Parameters that influence chemical attack.

Topic 5: Physicochemical and surface properties of crystals.
- Formation and state of the glass surface.
- Physicochemical properties of the glass surface.
- Surface modifications. Surface treatments.

Topic 6: Glass manufacturing.
- Manufacturing of flat glass.
- Manufacturing of glass for glasses.
- Annealing of glass.

Topic 7: Glasses for optical and ophthalmic applications.
- Classification of optical glass.
- Ophthalmic glass.
- Optical filters, coloured crystals and mirrors.
- Photosensitive and photochromic glasses.
- Recent optical applications.

Topic 8: Metal frames.
- Metals and alloys used in frames.
- Corrosion of metals and protective treatments.
- Shape memory alloys.

Related activities:
Application exercises I. Exercises on the contents of topics 1, 2 and 3.
Application exercises II. Exercises on the contents of topics 4, 5 and 6.
Application exercises III. Exercises on the contents of topics 7 and 8 and review of the previous ones.

Practice 0. Explanation of the laboratory and the organization and content of the practices. Practice 1. Physical and chemical properties of inorganic glass.
1.1. Physical properties of a mineral crystal.
1.2. Optical properties: UV-vis spectrophotometry.
1.3. Engraving of a mineral crystal.
Practice 2. Mechanical resistance of inorganic glass. Corrosion of a metal.

2.1. Impact resistance and thermal treatments of crystals.
2.2. Corrosion of a steel.
Practice 5. Electrolytic coatings.

2 partial tests.
Laboratory test.
Supervised work.

Full-or-part-time: 75h
Practical classes: 22h 30m
Laboratory classes: 7h 30m
Self study : 45h

2. ORGANIC MATERIALS

Description:
This content covers the following topics:

Topic 9: Definitions, classification and synthesis of polymers.
- Macromolecules, polymers and plastics.
- Classification of polymers: origin, form, production reaction, physical properties and nature of monomers.

Topic 10: Polymer synthesis.
- Polyaddition and polycondensation.
- Phases of the polymerization reaction, copolymerization kinetics and properties of copolymers.

Topic 11: General properties of polymers.
- Types of bonds in macromolecules (covalent, polar, H bridges, Van der Waals interactions).
- Relationship between chemical structure and properties: thermoplastics, thermosets and elastomers. Crystallinity and transparency.
- Correlation between the properties of a polymer and its structural unit.
- Thermal, mechanical and optical properties. Density and water absorption.
- Modification of properties with additives: dyes, pigments and plasticizers.

Topic 12: Organic frames.
- Thermoplastic materials: cellulose acetate and cellulose propionate, PMMA and polyamide.
- Thermosetting materials: epoxy resins and carbon fiber.
- Additives used in obtaining frames.
- Manufacturing of frames.

Topic 13: Materials for ophthalmic lenses.
- Thermoplastic lenses (PC derived from bisphenol A, PMMA, polystyrene, PMMA/PS copolymer) and thermosetting lenses (CR-39 and copolymers with DAP and DATP).
- Properties of materials for ophthalmic lenses: hardness, abrasion resistance, refractive index and Abbe number.
- Hardening, anti-reflective and coloring treatments for ophthalmic lenses.
- Photochromic compounds for organic lenses.
- Obtaining ophthalmic lenses.

Unit 14: Materials for contact lenses.
- Materials for hydrophobic contact lenses: PMMA, CAB. Silicone lenses. Siloxanyl-acrylate and fluorosiloxanyl-acrylate lenses.
- Materials for hydrophilic contact lenses. Hydrogels.
- Properties of hydrogels: water content (WC), gas permeability (DK), refractive index and dependence between them. Influence of pH and % of cross-linking agent. Silicone hydrogels. The ideal contact lens and its relationship with the physicochemical properties of the material.

Related activities:
Application exercises IV. Exercises on the contents of topics 9 and 10.
Application exercises V. Exercises on the contents of topics 11, 12 and 13.
Application exercises VI. Exercises on the contents of topic 14 and review of the previous ones.

Presentation of the work. Oral presentation of the bibliographical work.

Practice 3. Properties of organic materials.
3.1. Physical properties of monomers.
3.2. Physical properties of polymeric materials.
3.3. Optical properties: UV-vis spectrophotometry.
Practice 4. Polymerization and coloration.
4.1. Polymerization.
4.2. Coloration of a polymeric material.
Practice 5. Absorption, water content and contact angle.
5.1. Water absorption of a polymeric material.
5.2. Measurement of contact angles.
5.3. Water content of a contact lens.

2 partial tests. Laboratory test. Supervised work.

Full-or-part-time: 75h
Practical classes: 22h 30m
Laboratory classes: 7h 30m
Self study : 45h

ACTIVITIES

2. LABORATORY PRACTICE

Description:
Practice 0. Explanation of the laboratory and the organization and content of the practices. Practice 1. Physical and chemical properties of a mineral crystal.
Optical properties: UV-vis spectrophotometry.
Engraving of a mineral crystal.
Practice 2. Impact resistance and heat treatments of crystals.
Corrosion of a metal.
Practice 3. Physical properties of organic monomers. Physical properties of polymeric materials.
Practice 4. Polymerization.
Coloration of a polymeric material.
Abrasion resistance.
Practice 5. Water absorption of a polymeric material.
Water content in a contact lens.
Measurement of contact angles.
Electrolytic coatings.

The practices will be carried out in the laboratory, in pairs, with a duration of 2 hours per session.

Specific objectives:
In the practical sessions, students must be able to:
- Know the location of the material to be used in the practical sessions, the instruments to be used during said sessions and the location of the reagents and general use material.
- Understand the programming of the practical sessions throughout the course and the laboratory rules.
- Know the precautions to be taken in the laboratory to prevent accidents.
- Acquire data and record experimental observations.
- Present results in tables and graphs and prepare a report.
- Relate the practical sessions to the theoretical knowledge of the subject.

Material:
All the materials and reagents needed to carry out the experiment are in the laboratory.
Detailed script of the experimental development of the practices, with the experiment questionnaire.

Delivery:
Laboratory report with questionnaire and experiment results. It will be handed in the week after the practice.
The teacher will return it corrected. The average of the laboratory reports (NL) is calculated.

Full-or-part-time: 12h
Laboratory classes: 12h

2. APPLICATION EXERCICES

Description:
Application exercises I. Exercises on the contents of topics 1, 2 and 3.
Application exercises II. Exercises on the contents of topics 4, 5 and 6.
Application exercises III. Exercises on the contents of topics 7 and 8 and review of the previous ones.
Application exercises IV. Exercises on the contents of topics 9.
Application exercises IV. Exercises on the contents of topics 9 and 10.
Application exercises V. Exercises on the contents of topics 11, 12 and 13.
Application exercises VI. Exercises on the contents of topic 14 and review of the previous ones. Presentation of the work. Oral presentation of the bibliographic work.

Session of exercises and problems that must be done individually or in small groups of 2-3 people, lasting 2 hours. Students must work in class on exercises and problems selected by the teacher.
Completion of exercises, questions and problems in the classroom from content 1 and 2 of the subject. Correction by the teacher.

Specific objectives:
When completing the practical seminar session, students must be able to:
- Relate the proposed exercises to the more theoretical aspects explained in class.
- Learn to solve short questions and problems.
- Orally present a monographic work on one of the aspects covered in the subject.

Material:
Topic notes and presentations (in PowerPoint), available at Atenea. Collection of assessment exercises.

Delivery:
The exercises and problems completed during the corresponding sessions will serve to consolidate the concepts and processes seen in the theory and practical classes. The assessment of the attainment of this knowledge will be carried out through partial tests and the laboratory test. As for the oral presentation of the work, it will be done during class hours at the end of the course and will have a weight of 50% of the grade for the work (the other 50% will correspond to the written work).

Full-or-part-time: 14h
Practical classes: 14h

3. BIBLIOGRAPIC REPORT

Description:
Write a monograph, in English, on a material or process covered in the subject. Work in a group of 3-5 people.

Specific objectives:
At the end of the activity, students should be able to:
Carry out a bibliographic search on a specific topic.
Extract the data of interest from all the available information.
Relate the structure to the properties of the compound of interest.
Present the written work following the usual conventions of a scientific work.
Orally present the information found in an understandable way.

Material:
Computer centre computers, basic bibliography of the subject, scientific articles.

Delivery:
Written and oral presentation of the work in English. Its grade (NTD) represents 5% of the final grade for the course (50% for the written work and 50% for the oral presentation).
As the work will be in English, it will also be assessed, in parallel and in addition to the content, in terms of the transversal competences assigned to the subject: third language and oral and written expression. In this sense, the two competences will have the same weight when assessing them.
In this sense, the competence in the third language will take into account in the same way the level of the language of the written work and that of the oral presentation. Both the written work and the oral presentation will allow the level of oral and written expression to be assessed.

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

4. PARTIAL EXAMS

Description:
Individual completion of exercises, questions and problems from contents 1 and 2 in the classroom. Correction by the teacher.

Material:
Notes with exercises on the content and presentations (in PowerPoint), available at Atenea for exam preparation. They cannot be brought on the day of the exam.
Statement of the exercise and calculator to take the test. Official subsequent resolution with correction criteria, available on the day of the exam review.

Delivery:
Students will complete the tests. The total of the four tests represents 80% of the final grade (20% for each test).

Full-or-part-time: 4h
Practical classes: 4h

5. FINAL EXAM

Description:
Individual completion of a final exam by students who have not passed the subject for the course. The partial exams to be taken in this re-evaluation will be indicated at the end of the course. Correction by the teacher. This corresponds to the official final exam according to the exam schedule set by the FOOT at the beginning of the course. Those people who, despite having passed the course, wish to improve their grade can also take this exam, but in this case they must request it in advance.

Material:
Notes with exercises on the content and presentations (in PowerPoint), available at Atenea for exam preparation. They cannot be brought on the day of the exam. Statement of the exercise and calculator to complete the test. Subsequent official resolution with correction criteria, available on the day of the exam review.

Delivery:
Resolution of the test by the students.

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

6. LABORATORY TEST

Description:
Individual implementation in the laboratory of one of the experiences (chosen at random) that the students have previously carried out.

Material:
On the day of the test you can bring your practice scripts, calculator, graph paper and ruler.

Delivery:
At the end of the experience, students must hand in the related questions indicated by the professor. This represents 5% of the final grade for the course.

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

EUROPEAN DIPLOMA IN OPTOMETRY COMPETENCES

Description:
This module contributes to the European Diploma in Optometry competencies indicated in the following link:
https://drive.google.com/drive/folders/1bwmHBsvkrGnY63DfXAnWZB_i0I2pXa-I?usp=drive_link

GRADING SYSTEM

The final grade is the sum of the following subgrades:
Nfinal = 0.20 Np1 + 0.20 Np2 + 0.20 Np3 + 0.20 Np4 + 0.10 NL + 0.05 NPL + 0.05 NTD.

Nfinal: final grade for the course.
Np1: mark for part-test 1.
Np2: mark for part-test 2.
Np3: mark for part-time test 3.
Np4: mark for the mid-term examination 4.
NL: average mark for the laboratory reports.
NPL: mark for the laboratory test.
NTD: grade for the written directed work and oral presentation.

Partial tests 1 and 2 consist of questions on concepts associated with the learning objectives of the subject in terms of knowledge and understanding of the first part of the syllabus (topics 1-7) and a set of application exercises.
Partial tests 3 and 4 consist of questions on concepts associated with the learning objectives of the subject in terms of knowledge and understanding of the second part of the syllabus (topics 8-12) and a set of application exercises.

The laboratory test will consist of the experimental performance of one of the experiments that the students have carried out in the laboratory and the presentation of the corresponding questionnaire (NPL). This mark will be worth 5 % of the course mark, and the average of the written reports submitted for each practical will be worth 10 % of the final mark. Thus, the practicals will have a weight of 15 % in the final grade of the course.
The directed work consists of the presentation in English, both oral and written, of a bibliographical work elaborated by the students in small groups (3-5 people) on a subject of the course. This work will be worth 5 % of the final mark for the subject.

Transversal competences:
CT03. Oral and written expression.
CT07. Third language.
will be considered achieved by completing the laboratory practicals and handing in the proposed bibliographic work. The mark for these competences will be the mark for the practical and the work, respectively.

The assessment of the competences of the European Diploma will be considered as achieved if the final mark for the subject is equal to or higher than 5.

Students will be able to pass the subject per year if the average of the partial marks, the practical mark and the work mark (i.e. Nfinal) is ≥ 5.
In the event of failing the subject per year, students may sit a make-up exam for the parts they have failed on the day of the official final exam of the subject according to the FOOT academic calendar. Those students who wish to take this final exam to improve their mark may also do so, but they must apply for it beforehand.
To access the re-evaluation of the subject it will be necessary to fulfil the general conditions established each year by the academic regulations of the UPC's bachelor's and master's degree courses (NAGRAMA) and the specific conditions of the FOOT (having obtained a final mark for the subject equal to or higher than 3.5). The re-evaluation exam will consist of a single theoretical test on all the topics developed in the subject during the course, which will be worth 100% of the mark. Students who pass the re-evaluation exam will receive a final grade of 5 for the course. Otherwise, the highest grade obtained in the previous evaluation and the re-evaluation will be maintained.

EXAMINATION RULES.

In order to obtain the average of the marks, it is a necessary condition to have done all the laboratory practicals and seminars and to have handed in the corresponding reports.

In the case of partial or total copying in any of the subject evaluations, the provisions of the academic regulations of the UPC's bachelor's and master's degree courses will be applied:
"Irregular actions that may lead to a significant variation in the grade of one or more students will constitute a fraudulent performance of an assessment act. This action will lead to the descriptive grade of failure and a numerical grade of 0 for the evaluation act and the subject, without prejudice to the disciplinary process that may arise as a result of the acts carried out. If the student considers the decision to be incorrect, he/she may lodge a complaint with the director or dean of the faculty or school and, if the response is not satisfactory, he/she may lodge an appeal with the rector. The total or partial reproduction of academic or research work, or its use for any other purpose, must have the explicit authorisation of the authors. It shall be the responsibility of the director or dean of the faculty or school to resolve any allegations regarding aspects not included in the regulations.

BIBLIOGRAPHY

Basic:
- Navarro Sentanyes, Antonio. Materiales ópticos inorgánicos. Terrassa: el Departament, D.L. 1997. ISBN 849225081X.
- Navarro Sentanyes, Antonio. Materiales ópticos orgánicos : monturas y lentes. [Barcelona?]: l'autor, cop. 2007. ISBN 9788492250851.
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Complementary:
- Mari, Eduardo Ambrosio. Los vidrios : propiedades, tecnologías de fabricación y aplicaciones. Buenos Aires: América Lee, 1982. ISBN 9500066173.
- Ahluwalia, V. K.; Mishra, Anuradha. Polymer science : a textbook. Boca Raton: CRC/Taylor & Francis, 2008. ISBN 9781420068191.
- Pethrick, Richard A. Polymer science and technology : for scientists and engineers [on line]. Dunbeath: Whittles, cop. 2010 [Consultation: 25/07/2024]. Available on: https://search-ebscohost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=1107613&site=ehost-live&ebv=EB&ppid=pp_Cover. ISBN 9781904445401.