**COURSE GUIDE** 2021/22

**Faculty** 215 - Faculty of Chemistry **Cycle** Not Applicable

**Degree** GQUIMI20 - Bachelor's Degree in Chemistry **Year** Fourth year

## COURSE

26119 - Macromolecular Materials II: Processing **Credits, ECTS:** 6

## COURSE DESCRIPTION

The subject begins with an introduction to Rheology, locating the particular features of macromolecular materials and their behaviour between elastic solids and Newtonian liquids. Rheological knowledge is the basis for the later study of methods to process or convert these materials into useful products. The objectives are: provide students with the theoretical knowledge and practical experience needed to understand the behaviour of polymer flows, and use the main industrial techniques for processing these materials in the context of correlations between structure, rheology, processing and properties.

## COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

This subject is included in the minor called "Macromolecules", located in the Advanced Module of the Degree and so, its transversal competencies will be evaluated. Among them, the following will be worked:

M03CM17: Demonstrate observation, analysis and synthesis skills with a capacity for criticism and self-criticism.

M03CM18: Demonstrate a capacity for learning and for autonomous work for professional development.

M03CM20: Relate chemistry with other disciplines and understand its impact on the industrial and technological society and the importance of the industrial chemical sector.

The specific competencies of this subject are:

M03CM05: Acquire knowledge and develop skills to use the main methods for transforming macromolecular materials into useful products. Possess basic knowledge of the rheological foundations on which said transformations are based.

M03CM11: Be able to design, programme and carry out experimental processes and use adequate instrumental techniques for different types of chemical problems.

M03CM12: Possess knowledge of the network tools and services that enable searches for information in the field of chemistry and similar fields.

The coordination of this subject with the others included in the same module is up to the Undergraduate Degree Coordination Comission.

## CONTENIDOS TEÓRICO-PRÁCTICOS

Introduction. Basic definitions and concepts. Non-newtonian liquids. Viscoelastic response. Rheology and processing.
Flow in polymeric liquids. Simple continuous flow: pseudoplastic or sher thinning behaviour. Oscillatory flow: dynamic viscoelasticity. The influence of temperature and molecular parameters.
Rheological techniques. Measurement of the effect of shear rate on the viscosity. Measurement of the viscoelasticity. Capillary rheometry. Torsion rheometers.
Operations before processing: Drying of polymers and blending in macromolecular materials (mixing and additive addition).
Continous processing techniques: Extrusion. Calendering. Applications.
Cyclic processing techniques: Injection molding. Blow molding. Thermoforming. Molding of thermoset materials. Other cyclic processing techniques. Applications.

## TEACHING METHODS

The methodology for teaching the subject consists (in the case of the Theoretical Programme) of lectures in which computers will be used extensively to project the content. Students also participate in seminars where they present the results and conclusions obtained in practical work in the laboratory or specific themes proposed by the professor.
The laboratory practical work will be done in 3-hour sessions in the afternoons, linking in with the timetable for the period of theoretical classes. During the practical sessions, the processes and the functioning of machines will be explained, together with the experimental conditions to be applied. In groups of 3-4, students will then perform experiments, noting down any incidents and the data obtained. Finally, an analysis and discussion of the results will be carried out. For each practical work exercise, this will be reflected in a report that will be prepared by the group and presented for grading.

## TYPES OF TEACHING

| Types of teaching | M | S | GA | GL | GO | GCL | TA | TI | GCA |
|---|---|---|---|---|---|---|---|---|---|
| Hours of face-to-face teaching | 40 | 5 | | 15 | | | | | |
| Horas de Actividad No Presencial del Alumno/a | 60 | 10 | | 20 | | | | | |

**Legend:** M: Lecture-based | S: Seminar | GA: Applied classroom-based groups | GL: Applied laboratory-based groups | GO: Applied computer-based groups | GCL: Applied clinical-based groups | TA: Workshop | TI: Industrial workshop | GCA: Applied fieldwork groups

## Evaluation methods

- Continuous evaluation
- End-of-course evaluation

## Evaluation tools and percentages of final mark

- Written test, open questions 55%
- Exercises, cases or problem sets 25%
- Teamwork assignments (problem solving, Project design) 10%
- Oral presentation of assigned tasks, Reading¿ 10%

## ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

1) In the ordinary evaluation, a final written exam will be held that may contain questions of a theoretical and practical nature; it will represent 55% of the final mark. During lectures, at the end of each theme, tests will be set through the use of interactive response controls. This evaluation may partially replace the final exam.

2) Continuous evaluation of students based on participation in interaction activities in class (controls, projects, explanations...) and/or the performance/resolution of exercises. This modality will account for 20% of the final mark and is compulsory for students who opt for continuous evaluation.

3) An evaluation of practical laboratory work will be made based on the attitude and progress observed, and on documents/reports on the work done. This evaluation will represent 25%. Attendance at practical laboratory work will be essential to pass the subject.

The criteria for opting for evaluation in a final exam are those stated in chapter 2, article 8 of the Regulations governing student evaluation in undergraduate degrees of the UPV/EHU.

If a student opts for evaluation in a final exam, not presenting him/herself for that exam will mean that he/she withdraws from the evaluation and will be considered "Not Present".

The criteria for opting out of continuous evaluation are those stated in chapter 2, article 8 of the Regulations governing student evaluation in undergraduate degrees of the UPV/EHU.

## EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the extraordinary evaluation, a student may request that his/her marks are calculated in the percentages referred to in sections 2) and 3) of the ordinary evaluation rules (only if they have passed them). In this case, the student may only do the written exam in section 1), with its corresponding percentage value (55%).

If a student opts for evaluation through a single exam, or has not passed section 2) and 3) of the ordinary evaluation, he/she will take a single exam of a theoretical-practical nature, representing 100% of the final mark. This exam will be used to evaluate all the competences of the subject.

## MANDATORY MATERIALS

There is no compulsary material.

## BIBLIOGRAFÍA

### Basic bibliography


J. M. Dealy. Rheometers for Molten Plastics. Van Nostrand Reinhold, 1982.
J. Ferguson, Z. Kembloswsky. Applied Fluid Rheology. Elsevier Applied Science, 1991.
A. A.Collier. Thechniques in Rheological Measurements. Chapman and Hall, 1993.
G. Schramm. A Practical Approach to Rheology and Rheometry. Haake, 1994.
C. D. Han. Rheology in Polymer Processing. Academic Press, 1976.
J. M. Dealy, K. F. Wissbrun. Melt Rheology and its Role in Plastics Processing: Theory and Applications. Van Nostrand Reinhold, 1990.
A. Santamaría, M. E. Muñoz. Curso de Reología Aplicada. UPV/EHU, 2009.
A. Santamaria, E.Unzueta. Erreologia: Teoria eta Praktika. UEU, 1994.
M. L. Berins, Editor. Plastics Engineering Handbook. Van Nostrand Reinhold, 1991.
W. Michaeli. Plastics Processing, An Introduction. Hanser, 1995.
T. L. Richardson. Industrial Plastics. Delmar Publishers Inc., 1989.
J. M. Charrier. Polymeric Materials and Processing. Hanser, 1991.
W. Michaeli, H. Kaufmann, H. Greif. F. J. Vosseburger. Training in Plastics Technology. Hanser, 1995.
A. W. Birley, B. Hawort, J. Batchelor. Physics of Plastics. Processing, Properties and Materials Engineering. Hanser Publishers, 1991.


### Detailed bibliography


J. D. Ferry. Viscoelastic Properties of Polymers. Wiley, 1980.
W. W. Graessley. Polymeric Liquids and Networks: Dynamics and Rheology. Garland Science, 2008.
I. I. Rubin (ed.). Handbook of Plastics Materials and Technology. Wiley Interscience, 1990.
C. A. Harper (ed.). Handbook of Plastic Processes. Wiley, 2006.


### Journals

Polymer
Journal of Rheology
Rheologica Acta
Applied Rheology
Macromolecular Materials and Engineering
Polymer Engineering and Science
International Polymer Processing
European Polymer Journal
Journal of Applied Polymer Science

### Web sites of interest

http://www.rheology.org/
http://www.bsr.org.uk
http://rrc.engr.wisc.edu/
http://www.strictly-extrusion.com
http://www.ferris.edu/htmls/academics/course.offerings/hillm
http://www.polymer-age.co.uk
http://www.matweb.com
http://www.plastics.com
http://www.empirewest.com/academy/index.html
http://www.mdacomposites.org
http://www.plastunivers.es
http://www.mixers.com
http://www.apme.org

## OBSERVATIONS