Course guide
295765 - 295EM125 - New Challenges in Additivation and Degradation of Plastic Materials

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Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN MATERIALS SCIENCE AND ADVANCED MATERIALS ENGINEERING (Syllabus 2019). (Optional subject).
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: ORLANDO ONOFRE SANTANA PEREZ

Others: Segon quadrimestre:
NICOLAS CANDAU - Grup: T1
LEANDRO ISIDRO MARTÍNEZ OROZCO - Grup: T1
MARIA LLUÏSA MASPOCH RULDUA - Grup: T1
ROSE MARY RITA MICHELL URIBE - Grup: T1
ORLANDO ONOFRE SANTANA PEREZ - Grup: T1

PRIOR SKILLS

Solid knowledge on Structure and Properties of polymers.
Basic knowledge of organic chemistry.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMCEAM-01. (ENG) Dissenyar i desenvolupar productes, processos i sistemes, així com l'optimització d'altres ja desenvolupats, atenent a la selecció de materials per aplicacions específiques.
CEMCEAM-02. (ENG) Aplicar métodos innovadores para el diseño, simulación, optimización y control de procesos de producción y transformación de materiales
CEMCEAM-03. (ENG) Realizar estudios de caracterización y evaluación de materiales según sus aplicaciones
CEMCEAM-05. (ENG) Interpretar y aplicar normativas y especificaciones relativas a los materiales y sus aplicaciones
CEMCEAM-06. (ENG) Evaluar el tiempo de vida en servicio, la reutilización, la recuperación y el reciclaje de productos atendiendo a las características de los materiales que lo conforman

Transversal:
02 SCS. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

Participatory expository class of theoretical and practical contents. Support material available on the digital campus of the subject.
Laboratory practices -experimental work.
Reading of didactic material, texts and articles related to the contents of the subject
Group work – formal laboratory reports.

LEARNING OBJECTIVES OF THE SUBJECT

1. Know the main families of thermoplastics, both of fossil origin and biobased, their relevant characteristics and challenges related to eco-design and circular economy: structure, special properties and technological aspects.
2. Know the main identification techniques for polymeric materials: IR spectroscopy, combustion analysis.
3.Introduce the main families of elastomers, their relevant characteristics and challenges related to eco-design and circular economy in this type of material.
4. Know the main mixing and compounding techniques in the plastics industry.
5. Know the main mechanisms of thermo-oxidative degradation, UV.
6.Know the main stabilization additives against degradation-decomposition and the challenges that arise from the eco-friendly and circular economy.
7. Know the main fireproofing mechanisms in plastic materials and tests for their evaluation.
8. Know the main final performance additives used in formulations of plastic materials.
9.To publicize European initiatives and technological aspects related to the revaluation of recycled polymeric material.

STUDY LOAD

Type	Hours	Percentage
Hours small group	14,0	9.33
Hours large group	28,0	18.67
Self study	108,0	72.00

Total learning time: 150 h

CONTENTS

Topic 1. Mixing and compounding technology in the plastics industry

Description:
Types of mixing and estimation of process quality.
Polymer blending.
Preparation of formulations.
Main mixing and compounding techniques used in the plastics industry: Twin-screw extrusion, internal mixer, etc.

Related activities:
Laboratory session:

- Reactive mixing of polymers in internal mixer.

Full-or-part-time: 16h
Theory classes: 4h 30m
Practical classes: 1h 30m
Self study : 10h

Topic 2. IR spectroscopy applied to polymers.

Description:
Introduction to the technique. Sample preparation in polymeric systems.
Identification marches applied in polymers.
Quantitative analysis: estimation of the composition or progress of a reactive process. Beer-Lambert law.
Complementarity with identification by combustion behavior of polymers.

Related activities:
Directed work:
- Determination of blend/copolymer composition.

Full-or-part-time: 13h 30m
Theory classes: 1h 30m
Guided activities: 2h
Self study : 10h

Topic 3. Description of the main families of thermoplastics

Description:
Description of the main families of thermoplastic materials, both of fossil origin and bio-based, attending to the technological and industrial aspects of interest:
- Polyolefins
- Styrene-based polymers.
- Acrylic polymers
- Thermoplastic polyesters: aliphatic and aromatic.
- Polyamides
- Halogenated polymers.
- Bioplastics.

Full-or-part-time: 55h
Theory classes: 12h
Laboratory classes: 1h 30m
Guided activities: 4h
Self study : 37h 30m

Topic 5. Mechanisms of degradation and deterioration in polymers

Description:
Description of the main mechanisms of degradation (in aerobic and anaerobic conditions) and deterioration in fire of polymeric materials.

Description of the main stabilizing additives and their mechanisms of action.
-Antioxidants.
-Anti UV.
-Processing stabilizers
- Fireproof

Description of the main additives for performance and processing enhancement:
-Plasticizers/Lubricants.
- Clarifying/nucleating agents.
- Anti-static.
- Pigments and dyes.

Specific objectives:
Laboratory (developed in 4 face-to-face sessions)
Assessment of the effectiveness of two formulations agents of polymeric material:
- Session 1 and 2: Evaluation of stability during processing (MFI vs. Number of passes per extrusion)
- Session 3 and 4: Accelerated thermoxcidation: monitoring by DSC and FtIR.

Full-or-part-time: 54h 30m
Theory classes: 10h 30m
Practical classes: 6h
Self study : 38h

Topic 4. Elastomers and technological challenges

Description:
Description of the main families of elastomers, their most relevant characteristics and technological challenges related to eco-design and circular economy in this type of material.

Full-or-part-time: 11h 05m
Theory classes: 4h 30m
Self study : 6h 35m

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

All evaluations will be on a scale of 10. IMPORTANT: ALL EVALUATION ITEMS ARE MANDATORY IN ORDER TO PASS THE SUBJECT.
Evaluation items:
ExPr1: Partial Exam 1
ExPr2: Partial Exam 2
NAG: Note of group activities: 5 deliveries of group activities (lab activity reports)

The final grade (NF) will be calculated from the following expression according to the assumptions indicated below:

NF = 0.64NTory + 0.36 NAG

NAG: Average of laboratory reports and directed group activities.

Option 1: Assumed to exceed the minimum grade in each of the partial exams (4/10).

NTheory = 0.5 ExPr1 + 0.5 ExPr2

Option 2: Assumed NOT to exceed the minimum grade for each of the partial exams (4/10).

NTheory = 0.25 ExPr1 + 0.25 ExPr2 + 0.5 EF (final exam)

EXAMINATION RULES.

The partial exams (ExPr) will be carried out within the timetable of the subject. No notes. They will have a maximum duration of 75 min.

Reports of group activities (guided work): The teacher will indicate the form of delivery.
Laboratory session reports: The reports will be delivered according to the template available on the digital campus, paying special attention to the parts and form of presentation. These reports will be delivered in groups (number of people to be determined based on the number of students enrolled).

Final exam (EF):

Compulsory completion for those students who have not reached the minimum established grade (4/10) in each of the final exams. Maximum duration 2h. All topics covered throughout the semester will be evaluated. The use of notes is not allowed. Restricted the use of calculators "programmable" or included in mobile phone devices.

Failure to carry out any of the mandatory activities will automatically invalidate the evaluation line that it affects.

The course does not include a revaluation exam.

BIBLIOGRAPHY

Basic:
- Brydson, J. A.. Plastics materials. 7th ed. Oxford: Butterworth-Heinemann, 1999. ISBN 0750641320.
- Gächter, R.; Müller, H.. Plastics additives handbook : stabilizers, processing aids, plasticizers, fillers, reinforcements, colorants for thermoplastics. 3rd ed. Munich, [etc.]: Hanser, 1993. ISBN 3446175717.

Complementary:
- Murphy, John. Additives for plastics handbook [on line]. 2nd ed. Kidlington, Oxford: Elsevier Advanced Technology, 2001 [Consultation: 02/03/2020]. Available on: https://www.sciencedirect.com/science/book/9781856173704. ISBN 1856173704.

RESOURCES

Other resources:
Visual support material on the digital campus