INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Polymers Engineering in Biomedicine	Field of study	Biomedical Sciences
Master in	Biomedical Technology - Medical Signals and Instrumentation	School	School of Technology and Management
Academic Year	2019/2020	Year of study	1
Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	1
Code	5025-422-1102-00-19		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Maria Filomena Filipe Barreiro

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Know some historical and industrial perspectives on polymer science;
2. Identify the most relevant synthetic polymers, associated chemistry and used polymerization processes;
3. Recognize the most relevant, natural or natural-based polymers, having in view industrial applications;
4. Understand average molecular weight and polydispersity concepts, and know the major experimental determination techniques;
5. Understand polymer morphology, and know some experimental techniques to access structural, morphological and thermal characterization;
6. Know polymer processing techniques;
7. Know some specialty polymers and novel developments in polymer science with particular emphasis for biomedical applications.

Prerequisites

Before the course unit the learner is expected to be able to:
Demonstrate background knowledge of Mathematics, Physics and Organic Chemistry.

Course contents

Historical and industrial developments on polymer science. Polymer families and synthesis chemistry. Polymerization processes and techniques. Average molecular weight and related experimental techniques. Structural and morphological analysis. Experimental techniques for structural, morphological and thermal characterization. Processing techniques and rheology. Speciality polymers and novel developments in polymer science. Biomedical applications.

Course contents (extended version)

1. Introduction
   - Macromolecules, historical perspectives, technological and economic importance;
   - Monomer, polymer, repeating unit and polymerization degree;
   - Momopolymers and copolymers;
   - Tacticity;
   - Linear, branched and crosslinking polymers;
   - Amorphous and crystalline polymers;
   - Thermoplastic and thermoset polymers.
2. Synthetic polymers
   - Polyurethanes, polyamides, polyesters, polyethers, phenolic resins and epoxides;
   - Applications;
   - Polymers produced by polycondensation and polyaddition;
   - Polymerization techniques (bulk, solution, emulsion and suspension).
3. Natural and natural derived polymers
   - Natural rubber; polysaccharides, polyamides and polyesters;
   - Importance as biomaterials.
4. Degree of polymerization and molecular weight
   - Molecular weight distribution and average molecular weight;
   - Degree of polymerization and average molecular weight in number, weight;
   - Experimental determination of molecular weight: absolute and relative methods;
   - End-group analysis, membrane and vapour pressure osmometry, light scattering;
   - Intrinsic viscosity measurements and size exclusion chromatography.
5. Morphology concepts
   - Morphological changes: linear amorphous polymers, crystalline polymers and crosslinking polymers;
   - Glass transition temperature (Tg);
   - Melting temperature (Tm);
   - Crystalization kinetics;
   - Experimental techniques for determining crystalinity: density measures and X-ray diffraction;
   - Structure-properties relationship;
   - Effect of molecular weight and composition on Tg;
   - Experimental techniques for Tg and Tm evaluation: dilatometry and differential scanning calorimetry.
6. Technological aspects
   - Extrusion and molding techniques, composites, polymer blends, compounding;
   - Rheology of melted polymers: permanent and dynamic properties, viscoelastic memory.
   - Extrusion, injection and thermoforming processing. Composites, nanocomposites and polymeric blends.
7. Novel polymers and applications
   - Water-based, conducting polymers, polymers derived from renewable resources, microencapsulation;
   - Hydrogels, biocompatible and biodegradable polymers, adhesives devoted for biomedical applications.
   - Polymeric nanofibers and their applications.

Recommended reading

1. J. R. Fried, Polymer Science and Technology, 1st Edition, Prentice Hall, 1995;
2. M. Campbell, Introduction to Synthetic Polymers, 2nd Edition, Oxford University Press, 2000;
3. F. W. Billmeyer, Textbook of Polymer Science, 2nd Edition, John Wiley & Sons, 1984.
4. N. D. Polychronopoulos, J. Vlachopoulos, Polymer Processing and Rheology, Functional Polymers, 1st Edition, Springer International Publishing, 2019.

Teaching and learning methods

Theoretical classes: exposition of concepts, discussion and presentation of examples. Practical/laboratorial classes: supervised resolution of exercises and critical analysis of results. Experimental demonstration of concepts, identification/characterization of polymeric materials and synthesis assays.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
   - Development Topics - 50% (Two assignments (report and oral presentation). The second will include experimental development.)
   - Final Written Exam - 50%
2. Alternative 2 - (Regular, Student Worker) (Special)
   - Final Written Exam - 100%
3. Alternative 3 - (Student Worker) (Final, Supplementary)
   - Final Written Exam - 100%

Language of instruction

English

Electronic validation

Maria Filomena Filipe Barreiro	Hélder Teixeira Gomes	Fernando Jorge Coutinho Monteiro	Paulo Alexandre Vara Alves
06-03-2020	07-03-2020	10-03-2020	11-03-2020