COURSE DESCRIPTION CARD - SYLLABUS

Course name
Polymers and plastics [S1TOZ1>PiTS]

Course

Field of study
Circular System Technologies

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
45

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

5,00

Coordinators

dr hab. inż. Sławomir Borysiak prof. PP
slawomir.borysiak@put.poznan.pl

Lecturers

Prerequisites

The student should have a basic knowledge of general and organic chemistry. Student should also be able to search information from literature, databases and other properly selected sources.

Course objective

Providing knowledge in the field of preparation, structure, properties and applications of polymers and polymeric materials. Mastering the skills of polymer synthesis, plastic processing and characteristics of their thermal and physicochemical properties.

Course-related learning outcomes

Knowledge:
1. the student has the necessary knowledge in the field of synthetic and natural polymers as well as knows the technological methods for processing plastics [k_w10]
2. the student has a systematic, theoretically founded general knowledge in the field chemistry and physicochemistry polymers, in particular their structure and methods of obtaining polymers [k_w04]
3. the student has the necessary knowledge in the field of research methods to identify and characterize the physicochemical properties of polymer materials [k_w11]

Skills:
1. student has the skills to search information from literature, databases and other sources related to polymeric materials that can be interpreted [k_u01]
2. student has the skills to select plastic processing methods, with particular emphasis on the type of plastics and the shape of the final product [k_u10]
3. the student is able to select equipment and research apparatus to determine the chemical, physical and mechanical properties of polymers and plastics [k_u03]

Social competences:
1. the student is aware of the need for professional behavior and responsibility for decisions made during work involving the synthesis of polymers and processing of plastics [k_k01]
2. the student shows independence and inventiveness in individual work, and is able to work in a team, at the same time objectively assess the effects of own and team work [k_k02]
3. the student is able to objectively assess the level of his knowledge and skills, and is also aware of the need to improve professional competences, adequately to the changing state of knowledge and social aspects [k_k05]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lectures:
Knowledge acquired in lecture is verified in the form of a written exam after the end of the lecture cycle. The exam consists of 5-10 open questions and/or 30-40 test questions. Passing threshold: 50% of points. Exam issues will be sent to students via e-mail using the university e-mail system.
Laboratory:
The skills in the laboratory classes are verified on the basis of a test of theoretical issues, consisting of 3-5 questions. Theoretical issues for all exercises are passed on during the organizational meeting. Passing threshold: 50% of points. In addition, reports containing a description of the experiment and calculations are evaluated.

Programme content

1. Basic concepts in the polymers science (monomer, polymer, mer, degree of polymerization, functionality). Nomenclature of polymers. Polymer classification according to Flory and Carothers.
2. Properties and applications of selected polymers, eg. polyolefins, vinyl polymers, rubbers, polyesters, polyamides, polycarbonates, polyurethanes, epoxy and polyester resins, special polymers.
3. Chain polymerization - mechanism and types. Chain polymerization stages - initiation, propagation and termination. Radical, cationic, anionic polymerization, living polymerization. The influence of monomer structure on the polymerization mechanism. Polymerization kinetics, autocatalytic accelerations (gel effect). Copolymerization, types of copolymers, properties and application.
4. Coordination polymerization: types of catalysts, Ziegler-Natta catalysts, polymerization mechanism, specificity of the process (specific properties of formed polymers).
5. Industrial polymerization methods (bulk, suspension, in solution, emulsion, phase boundary).
6. Step polymerization. Polycondensation and types of polycondensation. Comparison of polymerization and polycondensation. Polycondensation reactions. Kinetics of the polycondensation process - equilibrium and non-equilibrium polycondensation, bifunctional and multifunctional polycondensation, Carothers equation. Polyaddition - mechanism, properties, examples of polymers obtained by polyaddition.
7. Industrial methods of polycondensation (in alloy, in solution, on the interface, in the solid phase).
8. Crosslinking of polymers: crosslinking methods, examples, vulcanization.
9. Polymer structure - forms of polymer chains (linear, branched, crosslinked), I, II, III-order structures - sequence of mers, cis-trans isomerism, tacticity, conformational forms, aggregation states, morphology of polymers, degree of crystallinity, crystalline and amorphous polymers - properties.
10. Molecular weight of polymers - types of molecular weights, polydispersion, influence of molecular weight on properties, molecular weight calculations. Degradation, depolymerization and destruction.
11. Plastics - definitions, classifications. Blends and polymer composites. Plastomers, elastomers, thermoplastics, duroplasts. Physical states and characteristic temperatures of polymers, thermal phase transitions, glass transition temperature.

12. Basic mechanical properties, viscoelasticity of polymers.
13. Basic methods of plastic processing - technological stages, extrusion, injection molding, pressing, thermoforming, calendering, spinning, rotomolding.
14. Natural and biodegradable polymers.
As part of the laboratory classes, the following exercises are performed:
1. Block polymerization of methyl methacrylate.
2. Polycondensation of polyamide 6,10 at the interface.
3. Production and characterization of polyurethane foams.
4. The foaming process of polystyrene.
5. Thermal properties of polymers determined by DSC method.
6. Identyfication of polymer materials.
7. Processing of polymeric materials - extrusion techniques.
8. Processing of polymeric materials - injection molding.
9. Processing of polymeric materials - thermoforming.

Teaching methods

1. Lecture: multimedia presentation
2. Laboratory: practical classes using chemical reagents and research equipment

Bibliography

Basic
1. J.F. Rabek, Współczesna wiedza o polimerach, PWN, Warszawa 2008
2. W. Szlezyngier, Tworzywa sztuczne, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 1996
3. J. Pielichowski, A. Puszyński, Technologia tworzyw sztucznych, WNT, Warszawa 2003
4. J. Pielichowski, A. Puszyński, Chemia polimerów, TEZA, Kraków 2004
5. B. Łączyński, Tworzywa wielkocząsteczkowe: rodzaje i własności, WNT, Warszawa 1982.
Additional
1. Z. Floriańczyk, S. Penczek, Chemia Polimerów, t.I , Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2001
2. D. Żuchowska, Polimery konstrukcyjne, WNT, Warszawa 2000
3. K. Czaja, Poliolefiny, WNT, Warszawa 2005

Breakdown of average student's workload

	Hours	ECTS
Total workload	127	5,00
Classes requiring direct contact with the teacher	77	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00