



COURSE DESCRIPTION CARD - SYLLABUS

Course name

Technology of polymeric materials

Course

Field of study

Chemical Technology

Area of study (specialization)

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

3/5

Profile of study

general academic

Course offered in

English

Requirements

compulsory

Number of hours

Lecture

30

Tutorials

Laboratory classes

30

Projects/seminars

Other (e.g. online)

Number of credit points

5

Lecturers

Responsible for the course/lecturer:

dr inż. Piotr Gajewski

Responsible for the course/lecturer:

Wydział Technologii Chemicznej

Instytut Technologii i Inżynierii Chemicznej

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Prerequisites



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

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 physicochemical properties.

Course-related learning outcomes

Knowledge

1. The student has a systematic, theoretically founded general knowledge in the field of polymer chemistry, in particular their structure and methods of obtaining polymers [K_W08]
2. The student has the necessary knowledge in the field of synthetic and natural polymers knows the technological methods for processing plastics [K_W09]
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 [K_U01]
2. Student uses basic laboratory techniques in the synthesis of polymeric materials [K_U20]
3. Student is able to characterize the chemical, physical and mechanical properties of polymers and plastics [K_U22]

Social competences

1. The student understands the need for further training and improving their professional competences [K_K01]
2. The student is able to work in a group and cooperate during performing practical tasks [K_K03]
3. The student is aware of the importance of the effects of engineering activities related to the plastics industry, in particular the impact on the environment [K_K02]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture. Stationary form: A written exam (consisting of 2 - 4 open and 20-30 closed questions) from the area of polymer chemistry presented during the lectures (student obtains a pass by achieving at least 51% of points). Online form: A test consisting of 40 - 50 questions (including >50% closed questions) from the area of polymer chemistry presented during the lectures (student obtains a pass by achieving at least 51% of points) on the eKursy platform.



Laboratory classes. Stationary form. Establishing a final grade on the basis of partial grades obtained during the semester: oral answers or written tests from the material included in the exercises and the given theoretical issues; the presence and performance of all laboratory exercises provided for in the study program; activity in the classroom and the way of exercise performance; grades from reports prepared after each exercise. Online form: Establishing a final grade on the basis of partial grades obtained during the semester; an oral answer and / or a written test (test, 10-20 closed questions) from the material contained in the exercises, instructional videos, and the theoretical issues provided, conducted in "live view" mode with the web camera on, in direct contact with the teacher via the platform eKursy; online presence and completion of all laboratory exercises provided in the study

Programme content

1. Basic concepts in the polymers science (monomer, polymer, mer, degree of polymerization, functionality). Nomenclature of polymer. 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, transitions, glass transition temperature.

12. Basic mechanical properties, viscoelasticity of polymers.

13. Basic methods of plastic processing - technological stages, extrusion, injection molding, pressing, thermoforming, calendaring, spinning, rotomolding.

14. Recycling of plastic - material recycling, compounds recovery and energy recovery.

As part of the laboratory classes, the following exercises are performed:

1. Block polymerization - synthesis of poly(methyl methacrylate)

2. Interfacial polycondensation – synthesis of polyamide 6.10

3. Cellular polymers - polystyrene foaming

4. Polyaddition – synthesis of polyurethane foam

5. Processing of polymeric materials - extrusion techniques

6. Processing of polymeric materials – injection molding

Teaching methods

Lecture: informative lecture with multimedia presentation.

Laboratory classes: performing experiments and getting acquainted with research equipment and chemical reagents used in their conduct, teaching materials for the laboratory in pdf files, tutorial videos on the eKursy platform.

Bibliography

Basic

1. S. Fakirov "Fundamentals of Polymer Science for Engineers", Wiley, 2017.

2. M. Rubinstein, R. H. Colby "Polymer Physics", Oxford, 2003.

3. R. A. Pethrick "Polymer Science and Technology for Scientists and Engineers", Whittless Publishing, 2010.

4. J. W. Nicholson "The Chemistry of Polymers", 5th ed., Royal Society of Chemistry, 2017.

Additional

1. A. Ravve "Principles of Polymer Chemistry", 3rd ed., Springer, 2012.

2. C.A. Harper. Ed. "Handbook of Plastics Technologies", 2006, e-book.



3. G.Odian "Principles of Polymerization", 4 th ed., Wiley, 2004.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,0
Classes requiring direct contact with the teacher	75	3,0
Student's own work (literature studies, preparation for laboratory classes, preparation for tests/exam, preparation of reports from laboratory classes) ¹	50	2,0

¹ delete or add other activities as appropriate