



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Recycling [S1Mech2>REC]

### Course

Field of study  
Mechatronics

Year/Semester  
2/4

Area of study (specialization)  
–

Profile of study  
general academic

Level of study  
first-cycle

Course offered in  
Polish

Form of study  
full-time

Requirements  
elective

### Number of hours

Lecture  
15

Laboratory classes  
30

Other  
0

Tutorials  
0

Projects/seminars  
0

### Number of credit points

4,00

### Coordinators

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### Lecturers

### Prerequisites

A student starting this subject should have a basic knowledge of mathematics, physics and general chemistry.

### Course objective

To learn about the basics of electrical, electronic and automotive waste management, including recycling and disposal processes for plastics and polymer and metal composites waste in accordance with the principles of a sustainable circular economy.

### Course-related learning outcomes

Knowledge:

The student has knowledge of the principles of waste management, technical activities in the field of secondary waste treatment (collection, sorting, segregation, shredding, proper processing). Student is able to indicate ecological, financial and legal aspects of recycling and recovery of plastics, metals and their alloys.

Skills:

Students will be able to identify and classify electro-waste (WEEE) and automotive waste (ELV), including hazardous waste, and choose the most appropriate way of disposing of it in a closed loop economy.

Social competences:

The student understands the importance of the relationship between raw materials, production, waste and the environment. The student understands the need for continuous education in sustainable management of electrical and electronic waste; automotive, including electric vehicles.

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written a test (20 questions), criterion: 3 from 50.1 to 60%, 3.5 from 60.1 to 70%, 4 from 70.1 to 80%, 4.5 from 80.1 to 90.0% and 5 above 90.1%.

Laboratory: Attendance to all classes. Positive assessments from reports and written answers for questions asked by a teacher.

### Programme content

Lecture\_plastics: Strategies for the development of recycling technologies for electronic and electrical and automotive waste in Poland and worldwide. Legislation on WEEE and ELV waste recovery. Recycling systems for cars and waste electronic equipment. Types of polymeric materials in electronic equipment and vehicles, including electrical equipment.

Lecture\_metals: global consumption of materials and energy for the production of metal elements, definitions and classifications of scrap intended for recycling, metal recycling technologies, technologies for recycling electronic and electrical waste.

Laboratory\_plastics. Flotation and electrostatic separation of mixed electronic and automotive plastic waste. Shredding of dismantling waste from electronic equipment and end-of-life vehicles. Production of regranulates from polymer mixtures. Processing and granulometric analysis of mechanical recycling products.

Laboratory\_metals: classification and segregation systems for metal waste and its alloys, methods of melting recycled metal alloys, quality assessment of elements manufactured from metal waste.

### Course topics

Lecture\_plastics: Recycling techniques, machinery and equipment for recycling plastics, rubber, etc. Preparation of waste for processing (segregation, separation, shredding, proper processing, etc.). Shredding of polymeric materials from electronic and automotive waste. Flotation-sedimentation and electrostatic separation techniques in polymer waste management. Optical techniques and near-infrared (NIR) spectroscopy in material identification systems. Industrial installations for regranulation, purification, refreshment of polymer waste. Feedstock recycling of plastic waste (pyrolysis, methanolysis, gasification). Incineration of post-consumer waste. Recycling of polyurethane foams, cables, used car parts. Methods for assessing the rheological characteristics of secondary polymeric materials recovered from waste electrical and electronic equipment and end-of-life vehicles.

Lecture\_metals: production of metals from secondary raw materials, ecological and economic aspects of the conditions for metal recycling, processing techniques for metal materials intended for recycling, vehicle recycling, recycling of iron alloys, recycling of aluminum and its alloys, recycling of copper and its alloys, recycling of zinc, recycling of lead, recycling of pratinates.

Laboratory plastic recycling: Shredding of plastic waste. Manufacture of regranulates from polymer blends. Processing evaluation of plastic regranulates. Granulometric analysis of polymer recyclates in terms of mechanical recycling.

Laboratory\_metals: methods of sorting metal waste, melting of thin-walled aluminum scrap, refining of aluminum alloys, assessment of the metallurgical quality of castings made from aluminum scrap

### Teaching methods

Lecture: multimedia presentation. Laboratory exercises: performing exercises, discussion, teamwork.

### Bibliography

Basic:

1. Czarnecka-Komorowska Dorota, Przetwórstwo tworzyw i kompozytów polimerowych w obiegu zamkniętym, Wyd. Politechniki Poznańskiej, Poznań 2023.
2. Tchobanoglous George, Kreith Frank, Handbook of Solid Waste Management, 2nd Edition. 2002, The McGraw-Hill Companies, Inc. ISBN: 9780071356237.
3. Allen Alexander , Stefano Pascucci and Fiona Charnley, Handbook of the Circular Economy Transitions and Transformation, De Gruyter 2023, <https://doi.org/10.1515/9783110723373>.
4. Wilczyński K. Reologia w przetwórstwie tworzyw sztucznych, Wyd. Naukowo-Techniczne, W-wa 2001.
5. Ulewicz M., Procesy odzysku i recyklingu metali nieżelaznych i stali, Wyd. Politechniki Częstochowskiej 2015. ISBN 978-83-7193-636-4.
6. Osiński, Jerzy. Wybrane zagadnienia recyklingu samochodów, 1951-2016

Additional:

1. Lerwen Liu, Seeram Ramakrishna, An Introduction to Circular Economy, Springer 2021
2. Stijn van Ewijk and Julia Stegemann, An Introduction to Waste Management and Circular Economy, UCLPRESS 2023,
3. Oprządkiewicz J., Technologie i systemy recyklingu samochodów, WNT Warszawa 2003.
4. Praca zbiorowa pod red. Jerzego J. Sobczaka, Odlewnictwo Współczesne. Poradnik Odlewnika, Wyd. Stowarzyszenia Technicznego Odlewników Polskich, Tom 1. Materiały, Kraków 2013. ISBN: 878-83-904306-9-0.
5. Brandrup, J., Bittner, M., Menges, G., and Michaeli, W. (1996) Recycling and recovery of plastics, Carl Hanser Verlag, Germany. ISBN: 9781800084650.

### Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00