Polish course name	**RECYKLING MATERIAŁÓW**
English course name	**MATERIALS RECYCLING**
Course code	**WIP-MDL-D1-MR-07**
Field of study	**Materials design and logistics**
Level of qualification	**First degree**
Form of study	**Full-time**
Semester	**7**
Number of ECTS points	**2**
Ways of assessment	**Test**

Number of hours per semester

Lecture	Seminar	Classes	Laboratory	Project
15		30		

TEACHERS:

Dr Bernadeta Gajda,

Dr inż. Artur Hutny,

Dr inż. hab. Adam Cwudziński, prof. PCz.

COURSE OBJECTIVES:

› **C1** Familiarizing students with the problems of waste management.

› **C2** Providing students with knowledge of the basic issues related to the engineering of metal recycling processes.

› **C3** Acquainting students with the recycling techniques of selected materials.

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES:

1. Knowledge of physics and chemistry in the field of physical and chemical properties of metals and non-metallic materials, elementary mathematics.
2. Basic knowledge of materials science.
3. Ability to work independently and in a group.
4. Ability to use literature sources and internet resources.

COURSE CONTENT

LECTURE

- **L1** The concepts of waste, secondary raw material and recycling. Recycling and minimization of stored solid waste and energy saving. Economic conditions for recycling. Impact on the natural environment.
- **L2** Classification of metallic waste and multi-material waste. The role and place of metal recycling in the raw material management system. Circular economy.
- **L3** Equipment used in recycling.
- **L4** Theoretical basis of pyro and hydrometallurgical processes used in metal recycling.
- **L5** Recycling of steel and other iron carrier waste. Scrap classification. Equipment used in the recycling of steel waste.
- **L6** Recycling of production waste.
- **L7** Modern technologies in aluminum recycling.
- **L8, L9** Recycling of waste containing critical metals. Recycling of used batteries and accumulators, tin cans, used cell phones.
- **L10** Problems of waste segregation on the example of municipal waste.
- **L11** Recycling of paper and glass.
- **L12, L13** Recycling of plastics. The problems.
- **L14** Development of end-of-life vehicles.
- **L15** Alternative fuels.

CLASSES

- **C1, C2** Methods for determining the chemical composition of waste and recycling products.
- **C3, C4** Exercises based on the use of differences in the physicochemical properties of materials included in the waste.
- **C5 - C8** Reminder of the basic chemical calculations used in ›Recycling (percentage, process efficiency).
- **C9 - C12** Calculations based on chemical reactions occurring in recycling processes. Test.
- **C13 - C16** Calculations used to prepare solutions of specific concentrations. **C17, C18** Calculations related to the separation of metals from solutions (electrolysis, cementation, precipitation of sparingly soluble compounds).

- **C19, C20** Analysis of data on the structure of municipal waste in cities, communes and provinces.
- **C21, C22** Analysis of regulations on segregation of household waste.
- **C23 - C28** Modern innovative technologies reducing the amount of waste. Review of English-language magazines.
- **C29, C30** Repetition of material. Test.

BASIC REFERENCES

1. Kucharski M.: Recykling metali nieżelaznych. Wydawnictwa AGH, Kraków 2010 r.
2. Ulewicz M., Siwka J.: Procesy odzysku i recyklingu wybranych Materiałów. Wydawnictwo WIPMiFS Politechniki Częstochowskiej, Częstochowa 2010 r.
3. Ulewicz M: Procesy odzysku i recyklingu metali nieżelaznych i stali. Wydawnictwo Politechniki Częstochowskiej, Częstochowa 2015 r.
4. Rosik-Dulewska Cz.: Podstawy gospodarki odpadami, PWN, Warszawa, 2015 r.
5. Critical Metals, Handbook, Edited by Gus Gunn, Jonh Wiley 2014 r.

SUPPLEMENTARY REFERENCE MATERIALS

1. Free M. L.: Hydrometallurgy- Fundamentals and Applications, Wyd. Wiley, 2013 r.
2. Schmitz Ch.: Handbook of Aluminium Recycling, Wyd. Vulkan-Verlag GmbH, 2006 r.
3. Czasopisma Hydrometallurgy, Waste Menagement, Recikling, Rudy i mtale nieżelazne - recykling, itp. z ostatnich 5 lat.

LEARNING OUTCOMES

- **EU1** The student knows the basic principles of waste management and systems Waste management.
- **EU2** The student knows universal and original technical systems of waste preparation for reuse.
- **EU3** The student knows the basics of metal recycling technology.
- **EU4** The student is able to make calculations related to recycling.

TEACHING TOOLS

› Multimedia presentations.
› Calculator, periodic table.

WAYS OF ASSESSMENT (F – FORMATIVE, P – SUMMATIVE)

› **F1**. Assessment of the implementation of tasks included in the curriculum - colloquium.
› **F2.** Assessment of self-preparation for tutorials.
› **P1**. Assessment of the mastery of the teaching material within the lectures - final test.

STUDENT WORKLOAD

Form of activity	Number of hours	ECTS
Contact hours with the teacher		
Lectures	15	0,6
Seminar		
Classes	30	1,2
Laboratory		
Project		
Test	1	0,04
Exam		
Total contact hours	46	1,84
Student's own work		
Getting acquainted with the indicated literature	2	0,08
Preparation for seminar		
Preparation for classes	2	0,08
Preparation for lab		
Project preparation		
Consultation		
Preparation for the exam		
Total student’s own work	4	0,16
Total number of hours/ ECTS points for the course	**50**	**2,0**

ADDITIONAL INFORMATION

Timetable of classes	https://wip.pcz.pl/dla-studentow/plan-zajec/studia-stacjonarne
Information about the consultation (time + place)	https://wip.pcz.pl/dla-studentow/konsultacje-dla-studentow

MATRIX OF LEARNING OUTCOMES REALISATION

Learning outcome	Reference of given outcome to outcomes defined for whole program	Course objectives	Course content	Ways of assessment
EU 1	K_W01, K_W08, K_U03, K_U09, K_K01,	C1, C3	L1 - L15	P1
EU 2	K_W01, K_U09, K_K01,	C1, C3	L1 - L15	P1
EU 3	K_W01, K_W03, K_U09, K_K01,	C1, C3	L1 - L15	P1
EU4	K_W01, K_W03, K_U03, K_U09, K_K01,	C2	C1 - C30	F1, F2

FORM OF ASSESSMENT - DETAILS

EU1 The student knows the basic principles of waste management and systems waste management.

- 2,0 The student does not know the basic principles of waste management and systems Waste management.
- 3.0 The student partially knows the basic principles of waste management and waste management systems.
- 3.5 The student almost knows the basic principles of waste management and waste management systems.
- 4,0 Student good. Student knows the basic principles of waste management and waste management systems.

› 4,5 The student knows almost very well the basic principles of waste management and waste management systems.
› 5,0 Student knows very well the basic principles of waste management and waste management systems.

EU2 The student knows universal and original technical systems of waste preparation for reuse.

› 2,0 The student does not know universal and original technical systems of waste preparation for reuse.
› 3,0 The student is partially familiar with the universal and original technical systems of waste preparation for reuse.
› 3,5 The student almost knows the universal and original technical systems of waste preparation for reuse.
› 4,0 The student knows well the universal and original technical systems of waste preparation for reuse.
› 4,5 The student knows almost very well the universal and original technical systems of waste preparation for reuse.
› 5,0 The student knows the universal and original technical systems of waste preparation for reuse very well.

EU3 The student knows the basics of metal recycling technology.

› 2,0 The student does not know the basics of metal recycling technology.
› 3,0 The student knows the basics of metal recycling technology.
› 3,5 The student knows the basics of metal recycling technology.
› 4,0 The student knows the basics of metal recycling technology well.
› 4,5 The student knows almost very well the basics of metal recycling technology.
› 5,0 The student knows the basics of metal recycling technology very well.

EU4 The student is able to make calculations related to recycling.

› 2,0 The student is not able to make calculations related to recycling.
› 3,0 The student is able to partially make calculations related to recycling.
› 3,5 The student is almost able to make calculations related to recycling.
› 4,0 The student is able to do calculations related to recycling well.
› 4,5 The student is able to make calculations related to recycling almost very well.
› 5,0 The student can make calculations related to recycling very well.