Polish course name	**MATERIAŁY METALICZNE**
English course name	**METALLIC MATERIALS**
Course code	**WIP-PLM-D1-MM-03**
Field of study	**Materials design and logistics**
Level of qualification	**First degree**
Form of study	**Full-time**
Semester	**3**
Number of ECTS points	**6**
Ways of assessment	**Exam**

Number of hours per semester

Lecture	Seminar	Classes	Laboratory	Project
30			30	

TEACHERS:

Dr hab. inż. Józef Iwaszko, prof. PCz.

COURSE OBJECTIVES:

- **C1** Provide students with basic knowledge about metallic materials, their classification and properties.
- **C2** Acquainting students with the methodology of shaping the properties of metals, learning the crystal structure of the basic phases occurring in metals and methods of obtaining the required microstructures and properties, selection of chemical composition and manufacturing technology.

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES:

1. Knowledge of physics, mathematics and general chemistry.
2. Knowledge of the rules of work safety when using machines and technological devices.

3. Ability to select measurement methods.
4. Ability to perform mathematical operations to solve given tasks.
5. Ability to work independently and in a group.
6. Skills of correct interpretation and presentation of one's own actions.

COURSE CONTENT

LECTURE

- **L1 - L3** What is metal? The main properties of metals. Characteristics of the metallic bond. Network structure of metals.
- **L4, L5** Theory of the metallic state.
- **L6, L7** The actual structure of metals. Characteristics of network defects. Polycrystalline structure of metals.
- **L8 - L10** Metal alloys - characteristics and classifications. Solid solutions and intermetallic phases - definitions and classifications.
- **L11, L12** Crystallization of metals - the mechanism of crystallization. Ingot crystallization. Solidification of feet in conditions of imbalance. Allotropic changes.
- **L13, L14** Plastic deformation and recrystallization of metals.
- **L15 - L17** Diagrams of phase equilibria of alloys - preparation method, main rules, cooling curves. Characteristics of phase equilibrium diagrams.
- **L18 - L20** Characteristics of the Fe-Fe3C diagram, characteristics of transformations and structural components, division of alloys according to the Fe-Fe3C diagram and their characteristics.
- **L21 - L23** Steel: terminology, steel classifications. Alloying elements in steel.
- **L24 - L26** Characteristics and classification of aluminum alloys and copper alloys.
- **L27 - L30** Characteristics and classification of magnesium and titanium alloys.

LABORATORY

- **Lab1 - Lab4** Health and safety training; Crystallographic aspects of the metallic state, the crystallization process of a metallic material .
- **Lab5 - Lab8** Diagrams of phase equilibrium of alloys - preparation methodology - theoretical and practical aspects.
- **Lab 9, 10** Research on the physicochemical properties of iron alloys.
- **Lab 11, 12** Research on the physical and chemical properties of copper alloys.

- **Lab 13 - Lab15** Research on the physical and chemical properties of aluminum alloys.
- **Lab 16 - Lab19** Research on mechanical properties of metallic materials.
- **Lab 20 - Lab22** Microstructural studies of iron alloys.
- **Lab 23 - Lab25** Microstructural examination of copper alloys.
- **Lab 23 - Lab25** Microstructural examination of aluminum alloys.
- **Lab 26 - Lab28** Microstructural studies of magnesium and titanium alloys.
- **Lab 29, 30** Assessment test.

BASIC REFERENCES

1. K. Przybyłowicz, S. Skrzypek, Inżynieria metali i technologie materiałowe, Dom Wydawniczy PWN, 2020 r.
2. K. Przybyłowicz, Strukturalne aspekty odkształcania metali, Wydawnictwo Naukowe PWN, 2018 r.
3. L. A. Dobrzański, M**etaloznawstwo z podstawami nauki o materiałach, WNT, 1996 r.**
4. L. Dobrzański, Podstawy nauki o materiałach i metaloznawstwo, WNT 2002 r.
5. M. Blicharski, Wstęp do inżynierii materiałowej, WNT Warszawa 1998 r.
6. K. Przybyłowicz, Podstawy teoretyczne metaloznawstwa, WNT Warszawa 1999 r.

SUPPLEMENTARY REFERENCE MATERIALS

1. M.F. Ashby, D.R.H. Jones, Materiały inżynierskie, t. I i II, tłum. ang. WNT, Warszawa, 1995/1996 r.
2. S. Rudnik, Metaloznawstwo, PWN, Warszawa, 1996 r.
3. S. Prowans, Metaloznawstwo, PWN, Warszaw, 1988 r.
4. J. Iwaszko, K. Kudła, Microstructure, hardness, and wear resistance of AZ91 magnesium alloy produced by friction stir processing with air-cooling, International Journal of Advanced Manufacturing Technology, 116, 1309 - 1323 (2021).
5. J. Iwaszko, K. Kudła, Surface remelting treatment of 7075 aluminum alloy – microstructural and technological aspect, 2020 Mater. Res. Express 7, 016523,

6. J. Iwaszko, K. Kudła Friction Stir Processing of Copper, Proc. of 28th International Conference on Metallurgy and Materials (METAL 2019), Brno, 2019 r., 1051-1056.
7. J. Iwaszko, Microstructural aspects of laser surface treatment of commercially pure (CP) titanium, Kovove Mater. 57 2019 11–18, DOI: 10.4149/km 2019.

LEARNING OUTCOMES

› **EU1** knows what a metal and metal alloy are, what their properties and structure are, has theoretical knowledge of terminology and the theory of the metallic state.
› **EU2** has knowledge of plastic deformation and recrystallization of metals and the influence of deformation on the properties of metallic materials.
› **EU3** knows how to prepare diagrams of phase equilibria and can analyze them, can discuss the Fe-Fe_3C diagram, know the basic transformations and division of alloys according to the Fe-Fe_3C diagram.
› **EU4** has knowledge of the classification, properties and application of metals and non-ferrous alloys as well as steel and cast irons.

TEACHING TOOLS

› Lecture with the use of audiovisual aids.
› Laboratory - research and measurement equipment, test stands.

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

› **F1**. Assessment of the implementation of tasks included in the curriculum.
› **F2.** Assessment of the mastery of the teaching material being the subject of laboratory tasks - final test.
› **P1.** Assessment of the mastery of the teaching material during lectures – exam.

STUDENT WORKLOAD

Form of activity	Number of hours	ECTS
Contact hours with the teacher		

Lectures	30	1,2
Seminar		
Classes		
Laboratory	30	1,2
Project		
Test	2	0,08
Exam	2	0,08
Total contact hours	64	2,56
Student's own work		
Getting acquainted with the indicated literature	28	1,12
Preparation for seminar		
Preparation for classes		
Preparation for lab	27	1,08
Project preparation		
Consultation	4	0,16
Preparation for the exam	27	1,08
Total student's own work	86	3,44
Total number of hours/ ECTS points for the course	**150**	**6,0**

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_W04, K_U03, K_K02,	C1, C2	L1 - L12 Lab1 - Lab4	F1, F2, P1
EU 2	K_W04, K_U03, K_K02,	C1, C2	L13, L14	F1, P1
EU3	K_W04, K_U03, K_K02,	C1, C2	L15 - L20 Lab5 - Lab8	F1, F2, P1
EU4	K_W04, K_U03, K_K02,	C1, C2	L21 - L30 Lab9 - Lab30	F1, F2, P1

FORM OF ASSESSMENT - DETAILS

EU1 the student knows what a metal and metal alloy are, what their properties and structure are, has theoretical knowledge of terminology and the theory of the metallic state

- 2,0 The student does not know what a metal and metal alloy are, what their properties and structure are, the student does not have theoretical knowledge of terminology and the theory of the metallic state.
- 3,0 The student has a basic knowledge of metals, alloys and their properties, structure and the theory of the metallic state.
- 3,5 The student has mastered the knowledge to an almost good degree about what a metal and a metal alloy are, what properties and structure they have, as well as the terminology and theory of the metallic state.

- 4,0 The student has mastered the knowledge to a good degree about what is a metal and a metal alloy and what are their main properties and structure, as well as terminology and theory of the metallic state.
- 4,5 The student has almost very well mastered the knowledge of metal and metal alloy, their properties and structure, as well as the terminology and theory of the metallic state.
- 5,0 The student has a very good knowledge of what a metal and a metal alloy are, what their properties and structure are, as well as the terminology and theory of the metallic state.

EU2 has knowledge of plastic deformation and recrystallization of metals and the influence of deformation on the properties of metallic materials.

- 2,0 The student has no knowledge of plastic deformation and recrystallization of metals and how deformation affects the properties, does not know the research methodology.
- 3,0 The student has a basic knowledge of plastic deformation and recrystallization of metals and how deformation affects the properties, briefly knows the research methodology.
- 3,5 The student has acquired an almost good knowledge of plastic deformation and recrystallization of metals and how deformation affects the properties.
- 4,0 The student has a good command of the knowledge of plastic deformation and recrystallization of metals and the influence of deformation on the properties of metallic materials.
- 4,5 The student has almost very well mastered the knowledge of plastic deformation and recrystallization of metals and how deformation affects the properties.
- 5,0 The student has very good knowledge of plastic deformation and recrystallization of metals and how deformation affects the properties, knows the research methodology very well.

EU3 knows how to prepare phase equilibrium diagrams and can analyze them, can discuss the Fe-Fe_3C diagram, knows the basic transformations and division of alloys according to the Fe-Fe_3C diagram.

- 2,0 The student does not know how to prepare phase equilibrium diagrams and is not able to analyze them, cannot discuss the Fe-Fe_3C diagram, does

not know the basic transformations and division of alloys according to the Fe-Fe_3C diagram.

- 3,0 The student has a basic knowledge of the methodology of preparing phase equilibrium diagrams, can briefly discuss the Fe-Fe_3C diagram, basic transformations and division of alloys according to the Fe-Fe_3C diagram.
- 3,5 The student has an almost good knowledge of the methodology of the preparation of phase equilibrium diagrams, and can describe the Fe-Fe3C diagram, basic transformations and division of alloys according to the Fe-Fe3C diagram to an almost good degree.
- 4,0 The student has mastered the knowledge of the methodology of preparing phase equilibrium diagrams, is able to describe the Fe-Fe_3C diagram, basic transformations and division of alloys according to the Fe-Fe_3C diagram.
- 4,5 The student has almost very well mastered the knowledge of the methodology of preparing phase equilibrium diagrams, can almost very well discuss the Fe-Fe_3C diagram, basic transformations and division of alloys according to the Fe-Fe_3C diagram.
- 5,0 The student has mastered the knowledge of the methodology of preparing phase equilibrium diagrams, can precisely discuss the Fe-Fe_3C diagram, basic transformations and division of alloys according to the Fe-Fe_3C diagram.

EU4 has knowledge of the classification, properties and application of metals and alloys of non-ferrous metals as well as steel and cast irons.

- 2,0 The student has no knowledge of the classification, properties and application of metals and non-ferrous alloys, as well as steels and cast irons.
- 3,0 The student has only a basic knowledge of the classification, properties and application of metals and non-ferrous metal alloys as well as steel and cast iron
- 3,5 The student has an almost good knowledge of the classification, properties and application of metals and alloys of non-ferrous metals as well as of steels and cast irons.
- 4,0 The student correctly uses the knowledge and solves the problems arising during the exercises on his/her own.
- 4,5 The student has almost very well mastered the theoretical and practical knowledge on the classification, properties and application of metals and non-ferrous metal alloys as well as steel and cast iron.

› 5,0 The student has mastered the theoretical and practical knowledge of the classification, properties and application of metals and non-ferrous metal alloys as well as steel and cast irons.