**Nazwa przedmiotu:**

Structural Materials Laboratory

**Koordynator przedmiotu:**

Prof. Krzysztof Różniatowski, PhD, DSc

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia I stopnia

**Program:**

Electric and Hybrid Vehicles Engineering

**Grupa przedmiotów:**

Materiały konstrukcyjne

**Kod przedmiotu:**

1150-00000-ISA-0120

**Semestr nominalny:**

2 / rok ak. 2022/2023

**Liczba punktów ECTS:**

1

**Liczba godzin pracy studenta związanych z osiągnięciem efektów uczenia się:**

1) Number of contact hours / - 15 including:
a) laboratory - 13 hours;
2) Work own student / The number of hours of independent work of student
 Student's own work - 15 hours, including:
a) 6 hours - ongoing preparation of the student for laboratory exercises, literature studies,
b) 7 hours - preparation of reports on completed laboratory exercises.

3) TOTAL - 28 hours

**Liczba punktów ECTS na zajęciach wymagających bezpośredniego udziału nauczycieli akademickich:**

1 ECTS point - number of contact hours - 15, including:
a) laboratory - 15 hours;

**Język prowadzenia zajęć:**

angielski

**Liczba punktów ECTS, którą student uzyskuje w ramach zajęć o charakterze praktycznym:**

1 ECTS point - 28 hours, including:
1) laboratory exercises - 15 hours
2) preparing for laboratory exercises - 6 hours. (exercise 1: 0 hours, exercises 2-7: 6 x 1 hour)
3) 7 hours - preparation of results, preparation of reports (7 x 1 hours per report on each exercise).

**Formy zajęć i ich wymiar w semestrze:**

|  |  |
| --- | --- |
| Wykład:  | 0h |
| Ćwiczenia:  | 0h |
| Laboratorium:  | 15h |
| Projekt:  | 0h |
| Lekcje komputerowe:  | 0h |

**Wymagania wstępne:**

Completed lecture Structural Materials, knowledge of basic groups of materials, methods of their formation, structure and properties. Basic knowledge of subjects Mathematics, Chemistry, Physics (including units, symbolism, simple calculations, optics).

**Limit liczby studentów:**

Brak

**Cel przedmiotu:**

Transmission of knowledge about the microstructure of metallic materials, methods for disclosure, and the shaping influence of microstructure on the properties of materials. Introduction to basic heat treatment of materials (such as steel alloys and non-ferrous materials). Demonstration of relationship between the treating material, the resultant structure and performance. Presentation of the basic groups of metallic materials - iron base alloys, copper and aluminum alloys. Demonstration of the phenomena occurring during recrystallization of the material (for example brass) . Preliminary preparation to apply for the destruction of the basic mechanisms of metallic product.

**Treści kształcenia:**

Preliminary exercise. Principles of metallographic, typical metallographic structure.
Study of the effect of carbon on the microstructure and hardness of the alloys from Fe-Fe3C phase diagram.
Plastic deformation and recrystallization.
Heat treatment of structural steel (quenching and tempering).
Microscopic examination of white, gray and ductile cast iron.
Macroscopic studies.
Major copper and aluminum alloys and ways of strengthening them (examples).
Summary exercise.

**Metody oceny:**

7 passing laboratory. The rating for the exercise is the result of the assessment of the preparation for the exercise and the evaluation report on the implementation of practical exercises. Include the evaluation of all positive with 7 laboratory exercises. The final grade is the result of partial marks. At the last class provided a summary of the exercises and discussion on the achievements of individual students.

**Egzamin:**

tak

**Literatura:**

1) Michael F. Ashby and D.R.H. Jones, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elsevier Ltd, 2014 (4th edition), ISBN: 978-0-08-096665-6
2) Carter, Giles F.; Paul, Donald E., Materials Science and Engineering, ASM International, 1991, ISBN 978-0-87170-399-6
3) Higgins, Raymond A., Engineering Metallurgy - Applied Physical Metallurgy, Elsevier, 1993, ISBN 978-0-340-56830-9
4) Smallman, R. E.; Ngan, A. H. W., Physical Metallurgy and Advanced Materials, Elsevier, 2007 (7th Edition), ISBN 978-0-7506-6906-1
5) Hosford, W.F., Physical Metallurgy, CRC Press, 2010 (2nd edition), ISBN 978-1-4398-1360-7

**Witryna www przedmiotu:**

Brak

**Uwagi:**

Brak

## Efekty przedmiotowe

### Profil ogólnoakademicki - wiedza

**Efekt 1150-00000-ISA-0120\_W1:**

The student understands the principle of the formation of the image of the structure, knows the principle of revealing the structure in metal alloys, understands the concept of microstructure and its relationship with the production technique and basic functional features, can distinguish between single-phase and multi-phase structure. The student is able to recognize different types of steel due to the variable carbon content, indicate those that are characterized by higher hardness, justify the variability of hardness as a function of the carbon content. The student is able to recognize and name qualitatively different cast iron structures. The student can explain the changes taking place in the structure and properties of metallic materials subjected to plastic deformation and recrystallizing annealing. Is able to propose and make a simple experiment allowing to determine the recrystallization temperature of single-phase brass after a given crumple. The student can explain the changes occurring in the steel subjected to the process of hardening and tempering. He can name the structures created during this process. Can justify the chemical composition of steels used for this strengthening process. Student is able to list and indicate the way of splitting such light alloys as alloys on the basis of copper and alloys on the aluminum matrix. He can recognize the characteristic structures of these materials and draw conclusions about the way they are shaped. He can indicate which of them are suitable for casting, which are typical alloys for plastic processing and which ones can be strengthened by the mechanism of isolation. The student is able to perform and explain a simple experiment of strengthening dural by means of supersaturation and aging. Student is able to carry out simple observations of construction materials in the macro scale - perform the process of deep pickling of welds, reveal the decomposition of sulphides in steel, the Bauman method. He is able to identify and name characteristic forms of breakthroughs (fatigue, short-term, fragile, plastic) and explain how they form

Weryfikacja:

Passing positive tests from 6 laboratory exercises (exercises 2-7), passing positive reports prepared after each exercise (exercises 1-7).

**Powiązane efekty kierunkowe:** K\_W02, K\_W04, K\_W09

**Powiązane efekty obszarowe:** T1A\_W03, T1A\_W04, T1A\_W03, T1A\_W06, T1A\_W08

### Profil ogólnoakademicki - umiejętności

**Efekt 1150-00000-ISA-0120\_U1:**

Student is able to use devices such as metallographic microscope, Rockwell hardness tester, laboratory furnace, reagents for etching metal alloys.

Weryfikacja:

Passing positive reports prepared after each exercise (exercises 1-7).

**Powiązane efekty kierunkowe:** K\_U09

**Powiązane efekty obszarowe:** T1A\_U09, T1A\_U12

### Profil ogólnoakademicki - kompetencje społeczne

**Efekt 1150-00000-ISA-0120\_K1:**

The student is able to work in a group, to share responsibilities between partners in the experiment, to exchange results carried out as part of one task using different devices.

Weryfikacja:

Passing positive reports prepared after each exercise (exercises 1-7).

**Powiązane efekty kierunkowe:** K\_K05

**Powiązane efekty obszarowe:** T1A\_K06