STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Methods of Metal Recovery**		Code **1010702311010720123**
Field of study **Technologie ochrony środowiska - stacjonarne**	Profile of study (general academic, practical) **(brak)**	Year /Semester **1 / 1**
Elective path/specialty **Ecotechnology**	Subject offered in: **Polish**	Course (compulsory, elective) **obligatory**
Cycle of study: **Second-cycle studies**	Form of study (full-time,part-time) **full-time**	
No. of hours Lecture: **2** Classes: **1** Laboratory: **-** Project/seminars: **-**		No. of credits **3**
Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**	
Education areas and fields of science and art **technical sciences** **Technical sciences**		ECTS distribution (number and %) **3 100%** **3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	A student knows the basic principles of environmental protection related to chemical production and waste management.
2	**Skills**	A student can obtain information from literature, databases and other sources of chemical sciences, he can interpret them, draw conclusions, and formulate opinions.
3	**Social competencies**	A student understands the need for further education and improvement of their professional and personal competences.

Assumptions and objectives of the course:

Gaining knowledge of the technology of copper and associated metals recovery by the pyrometallurgical, hydrometallurgical, and electrowinning processes.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. A student has in-depth knowledge of mathematics, physics and chemistry, and other areas relevant to the field of the study useful for describing and solving complex tasks in the field studied. - [K_W01, T2A_W01]
2. A student has an extended knowledge in the related fields of study. - [K_W02, T2A_W02]
3. A student has detailed theoretical knowledge covering selected topics in environmental protection. - [K_W03, T2A_W03]

Skills:

1. A student can use specialist literature, integrate the information making the interpretation and critical evaluation and on the basis formulate competent opinions and reports. - [K_U01, T2A_U01]
2. A student can outline directions for further learning and practice self-learning process. - [K_U03, T2A_U03]
3. A student is able to plan, prepare and give a presentation on the implementation of the research task and carry out substantive discussion. - [K_U05, T2A_U05]

Social competencies:

1. A student is able to work independently and in a team. - [K_K02, T2A_K02]
2. A student is aware of personal responsibility for the team work in a professional career. - [K_K03, T2A_K03]

Assessment methods of study outcomes

Final written exam.

Evaluation of team presentation on a given topic.

Course description

The lecture presentes global technologies for recovery of copper, zinc, lead, silver and other metals by pyrometallurgical, electrochemical and hydrometallurgical methods and some issues of flotation, leaching of ores, digestion of scrap, alloys, batteries, separation of metal ions by conventional and non-conventional extraction are discussed . Physico- chemistry of processes, efficiency and selectivity of the extraction and stripping, applied technologies, equipment and process modeling of extraction-stripping processes are considered. It provides information on non-dispersive extraction-stripping processes in the membrane modules. The exercises cover basic concepts of mass balance and mass balances in various processes are solved. In addition, students work on the basis of the newest scientific and technical literature related to the recovery of metals essential for the global economy and they prepare a presentation on the subject. The exercise include presentation of a method of determining the degree of extraction in a multi-stage co-current and counter-current extraction.

Basic bibliography:

1. K. Schmidt, J. Sentek, J. Raabe, E. Bobryk, Podstawy technologii chemicznej. Procesy w przemyśle nieorganicznym. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2004.

2. A. Ciszewski, Technologia chemiczna. Procesy elektrochemiczne, Wydawnictwo Politechniki Po-znańskiej, Poznań 2008.

3. Z. Ziołkowski, Ekstrakcja cieczy w przemyśle chemicznym, PWT, Warszawa 1961.

4. J. Rydberg, M. Cox, C. Musicas, G. R. Coppin, Solvent extraction and practice, Taylor & Francis, 2004. E-book in: MyiLibrary (na stronach biblioteki głównej PP: http://www.ml.put.poznan.pl/pl/1_2_1.html#m).

Additional bibliography:

1. J. Kępiński, Technologia Chemiczna Nieorganiczna, PWN, Warszawa,1984.

2. J. Szymanowski, Ekstrakcja miedzi hydroksyoksymami, PWN, Warszawa, Poznań 1990.

3. F.K. Crundwell, M.S. Moats, V. Ramachandran, T.G. Robinson, W.G. Davenport, Extractive Metallurgy of Nickel, Cobalt and Platinum-Group Metals, Elsevier, Oxford 2011. E-book na: Referex Engineering (on the web site of PUT library).

Result of average student's workload

Activity	Time (working hours)
1. Preparation for the test in the range of exercises and lectures.	14
2. Preparation for training.	10
3. Participation in lectures.	30
4. Participation in exercises.	15
5. Development of a specified topic and preparation of a presentation.	6

Student's workload

Source of workload	hours	ECTS
Total workload	75	3
Contact hours	45	2
Practical activities	30	1