STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Materials recycling in electrochemistry**		Code **1010702221010712091**
Field of study **Chemical Technology**	Profile of study (general academic, practical) **(brak)**	Year /Semester **1 / 2**
Elective path/specialty **Indrustrial Electrochemistry**	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: **-** Laboratory: **4** Project/seminars: **-**		No. of credits **7**
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 %) **7 100%** **7 100%**

Responsible for subject / lecturer:

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Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	The basic knowledge within chemistry, physics and mathematics acquired from the first-cycle studies in the fields: chemical technology, environmental technology, chemical and process engineering or other related fields. The student has knowledge in term of raw materials, products and processes used in the chemical industry he also has basic information on the design, construction chemical sources of energy.
2	**Skills**	Student can work individually and in teams, he is able to plan and carry out the chemical experiments, interpret the obtained results and draw conclusions. Apply the basic regulations and comply with the safety rules related to work performed.
3	**Social competencies**	Student understands the need for continuous training and are aware of their responsibility for collaborative tasks related to teamwork. Student is aware of the importance of behavior in a professional manner and comply with the rules of professional ethics.

Assumptions and objectives of the course:

Gaining knowledge in term of raw materials and mterials used in electrochemistry,methodes and technologies of their recovery and recycling, including materials used for preparation of modern chemical sources of energy. Skills of the laboratory experiments related to the recycling and recovery of materials arised from electrochemical wastes electrochemistry.

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

Knowledge:

1. Has knowledge of complex chemical processes involving correct selection of materials, raw materials, apparatus and equipment applied in the processes of neutralization and recovery and planning of laboratory experiments and drawing up the acquired results. - [K_W03]

2. Has a well-established knowledge in the field of occupational health and safety. - [K_W10]

Skills:

1. He is able to critically assess the results of experimental studies and to determine the direction of further research solving the problems in the field of chemical technology. - [K_U20]

2. He is able to design and evaluate the experiment course and the process in the field of chemical technology, is also able to make the analysis of possibilities of the unit processes integration due to the raw material and the final product, in accordance with the principles of economy of materials and energy, taking into account the principles of risk assessment. - [K_U21]

Social competencies:

1. Is aware of the limitations of science and technology related to environmental protection. - [K_K02]

Assessment methods of study outcomes

Rating of written answers within the subjects related to the theme of the laboratory

Current control of knowledge and practical skills, the correction for experimentation during laboratory classes.

An assessment of the final report achieved on the basis of experimental results.

A written final exam in the subject.

Course description

1.Introduction into the problems connected with water conditioning, solid and liquid waste management in electrochemical industry, especially related with metal surface finishing and chemical power sources production.

2.Technologies of galvanic coating application

3.Conservation and regeneration of selected solutions.

4.Secondary utilization of spent solutions.

5.Methods used for treatment of liquid and solid waste, for solutions regeneration, materials recovery and recycling.

6.Recovery of metals from post neutralization sludge

7.Reprocessing and recycling technologies of spent lead-acid batteries

8.Reprocessing and recycling technologies of alkaline batteries

9.Reprocessing and recycling technologies batteries and cells containing Zn and Mn

10.Piro- and hydro-metarullurgical methods of processing of batteries and cells

11.Reprocessing and recycling technologies of spent lithium cells and lithium ion batteries

12.Laboratories: students carry out the neutralization of several types of galvanic wastewater (using different methods: precipitation, coagulation, electrochemical and chemical processes)associated with the recovery selected anions and metals. Students use galvanic sludges as a source of raw materials.

Basic bibliography:

1. T.Stefanowicz, Gospodarka wodno-ściekowa i odpadowa w przemyśle elektrochemicznym, Wyd. Politechniki Poznańskiej, Poznań, 2001.

2. T.Stefanowicz, Otrzymywanie i odzysk metali oraz innych surowców ze ścieków i odpadów pogalwanicznych, Wyd. Politechniki Poznańskiej, Poznań, 1992

3. Praca zbiorowa, Poradnik galwanotechnika, WNT, Warszawa, 2002.

4. A. Czerwiński ? Akumulatory Baterie Ogniwa, Wyd. Komunikacji i Łączności, Warszawa, 2005.

Additional bibliography:

1. B.Bartkiewicz, Oczyszczanie ścieków przemysłowych, Wyd. Naukowe PWN, Warszawa 2010.

2. L.K Wang, N.K. Shammas, Y.-T. Hung (eds) Advances in Hazardous Industrial Waste Treatment CRC Press, Taylor and Francis Group, Boca Raton Fl. USA 2009.

3. S.A.K.Palmer, M.A.Breton, T.J.Nunno, D.M.Sullivan, N.F.Surprenant, Metal/Cyanide Containing Wastes Treatment Technologies, Pollution Technology Review No 158, Noyes Data Co, Park Ridge, New Jersey, 1988.

4. M. B. Hocking, Handbook of Chemical Technology and Pollution Control, Elsevier Inc. 2005.

5. A.M. Anielak Chemiczne i fizykochemiczne oczyszczanie ścieków, Wyd. Naukowe PWN, Warszawa 2000.

6. Praca zbiorowa pod red. Czerwińskiego A., Rogulskiego Z., Utylizacja i recykling zużytych akumulatorów i baterii, Przegląd Komunalny 4 (2005).

7. D.C.R. Espinosa, A. M. Bernardes, J.A.S. Tenório, An overview on the current processes for the recycling of batteries. J. Power Sources 135 (2004) 311.

8. E. Sayilgan, T. Kukrer, G. Civelekoglu, F. Ferella, A. Akcil, F. Veglio, M. Kitis, Hydrometallurgy 97 (2009) 158.

Result of average student's workload

Activity	Time (working hours)
1. Preparation for the exam and exam	25
2. Preparing for the laboratories	55
3. Consultation	5
4. Lecture	30
5. Laboratory classes	60

Student's workload

Source of workload	hours	ECTS
Total workload	175	7
Contact hours	95	4

Practical activities	115	5