Annex to Regulations for “visiting lecturers” programme

Proponent from WUT	
Title and degree	Full Professor, Ph.D.
Name and surname	MILEWSKI Jaroslaw
Faculty	Power and Aeronautical Engineering
E-mail address in the WUT domain	Jaroslaw.milewski@pw.edu.pl
Phone number	+48222345207

The person proposed as a visiting lecturer	
Title and degree	Emeritus Professor, Ph.D
Name and surname	Cassir Michel
Exact affiliation	Chimie ParisTech, PSL Research-University, 11 rue Pierre et Marie Curie, 75005, Paris, France
E-mail address	michel.cassir@chimieparistech.psl.eu
Description of achievements (1/2-1 page)	Michel CASSIR obtained his Ph.D. in 1977 at the University Pierre et Marie Curie. He is a senior researcher and founder of the research team “Interfaces, Electrochemistry, Energy” (I2E) of the Institut de Recherche de Chimie Paris (CNRS), Chimie ParisTech, PSL Research University. He was the former Director of the Research Laboratory LECIME, specialized in electrochemistry, fuel cells and energy devices. He was responsible for 20 years of the International Collaborations with Latin América. He has expertise in several areas of analytical chemistry, electrochemistry and surface science applied to high-temperature fuel cells, batteries, and varied topics. He published 280 scientific publications in Journals dedicated to Analytical Chemistry, Electrochemistry, Materials Science, Energy, Thin layers, and Catalysis. He presented around 400 conferences or posters at scientific events (96 invited conferences and 4 plenary conferences). He led around 35 industrial, European, or international research programs. He collaborates with universities and institutes all over the world. He is one of the major international scientists in the field of molten carbonates applied in fuel cells, electrolysis and carbon dioxide capture and valorization. He leaded and organized 5 editions of IWMCFC (International Workshop on Molten Carbonates Fuel Cells and Related Topics (France: Paris and Orleans. China, Korea, and Japan) and was Invited Editor in International Journal of Hydrogen Energy and Journal of Power Sources.

Code of the course	4606-VL-ES-00002	Name of the course	Polish	**Kluczowe zagadnienia waloryzacji wodoru i CO2: podejście elektrochemiczne**
			English	**Key issues in Hydrogen & CO2 valorisation: an electrochemical approach**
Type of the course	Specialty subject			
Course coordinator	Michel Cassir	Course teacher	Michel Cassir	
Implementing unit	Faculty of Power and Aeronautical Engineering	Scientific discipline / disciplines*	Environmental Engineering, Mining and Energy, Chemical Engineering, Materials Engineering	
Level of education	Doctoral studies	Semester	winter, 2024-10-21 .. 2024-10-25	
Language of the course	English			
Type of assessment	Credit	Number of hours in a semester	15	ECTS credits: 1
Minimum number of participants	12	Maximum number of participants	N/A	Available for students (BSc, MSc): Yes/~~No~~

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week					
	in a semester	15				

* does not apply to the Researcher's Workshop

1. Prerequisites

None

2. Course objectives

Understand Electrochemistry and Electrochemical Devices: Develop a comprehensive understanding of the principles of electrochemistry and the workings of key devices like fuel cells and batteries, focusing on their role in energy storage and conversion.

Explore the Hydrogen Economy and Renewable Energies: Gain insights into the concept of a hydrogen economy, its integration with renewable energy sources, and the potential impacts on sustainable energy systems.

Analyze Current and Future Applications of Fuel Cells: Investigate the latest developments in fuel cell technology, with a focus on new applications, the challenges of high-temperature fuel cells, and the role of thin layers in their efficiency and operation.

Learn Carbon Capture Technologies Using Molten Carbonates: Study the use of molten carbonates in capturing and valorizing carbon dioxide, emphasizing its importance in reducing greenhouse gas emissions and advancing environmental sustainability.

Develop Critical Analysis and Problem-Solving Skills: Cultivate the ability to critically analyze current challenges and emerging trends in electrochemistry and renewable energy, encouraging innovative thinking and solutions-oriented approaches to real-world problems.

3. Course content (separate for each type of classes)
Lecture
Bases of electrochemistry and electrochemical devices fuel cells and batteries Towards a hydrogen economy within the topic of renewable energies State-of-the-art of fuel cells with new applications and prospects Challenges of high-temperature fuel cells Role of thin layers in high-temperature fuel cells Molten carbonates for carbon capture and valorisation 15 hours
Laboratory
N/A

4. Learning outcomes

Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	Understanding of electrochemistry principles and electrochemical devices	SD_W1	Oral/written exam; research project
K02	Knowledge about the hydrogen economy and renewable energy sources	SD_W3	Presentation; discussion; essay
K03	Understanding of CO2 capture technologies	SD_W3	Research report; group work
Skills			
S01	Ability to critically analyze and solve problems	SD_U1 SD_U2 SD_U3	Tests; course assignments
S02	Ecological awareness and promotion of sustainable development	SD_K1	Interdisciplinary project; group discussions
Social competences			

SC01	Ability to work in a team and international collaboration	Development of intercultural competencies and collaboration	Group cooperation assessment; instructor feedback

*Allowed learning outcomes verification methods: exam; oral exam; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

Course participation: Active participation in lectures and discussions can be a valuable indicator of student engagement and understanding. Consider incorporating participation points into the overall assessment.

6. Literature

Primary references:

[1] *Southampton Electrochemistry group "Instrumental methods in Electrochemistry", Ellis-Horwood (1985).*

[2] *B.Trémillon, "Analytical electrochemistry and reactions in solution", Wiley (1997).*

[3] *V.S. Bagotsky, "Fundamentals of electrochemistry", Wiley-Interscience, (2005)*

[4] M. CASSIR, D. JONES, V. LAIR, A. RINGUEDE, *"Electrochemical (electrolysers) MRs : (fuel cells, electrolytic cells, hydrogen/oxygen pumping reactors, etc.)"*, Part III, Chapter 20 in "Handbook of Membrane Reactors", Woodhead Publishing Limited 2013 (Ed. A. Basile) 553-605.

[5] M. CASSIR, A. RINGUEDE, V. LAIR, *"Molten carbonates from fuel cells to new energy devices",* Chap. 17 in "Molten salts: from fundamentals to applications", Elsevier 2013 (Ed. H. Groult and F. Lanthelme) 355-366.

[6] M. CASSIR, A. MELENDEZ-CEBALLOS, *"Fuel cell: a general overview, applications and future trends"*, Chap. 6, in Engineering of membrane reactors for resource and energy efficient in the process industry, Wiley, 2016 (Eds A. Basile, M. de Falco, G. Centi, G. Iaquaniello) 23 pages.

Secondary references:

[1] D. CHERY, V. LAIR, M. CASSIR, "Overview on CO_2 valorisation: challenge of molten carbonates", Frontiers in Energy Research, 3 (2015) Article 43 1-10.

[2] E. GÛRBÜZ, V. ALBIN, V. LAIR, A. RINGUEDE, M. CASSIR, "Oxidation behaviour of H_2 and CO produced by H_2O and/or CO_2 reduction in molten carbonates: Effect of gas environment and hydroxides", Electrochim. Acta, 395 (2021) 139202.

[3] E. GÛRBÜZ, S. HUBERT, L. JORDANV. ALBIN, A. RINGUEDE, V. LAIR, M. CASSIR, "Reinforcement of the MCFC matrix by Al-based additives: Effect of lithiation", Ceramics Int. '8 (2022) 7448-7455.

[4] A. NECHACHE. B. BOUKAMP, M. CASSIR, A. RINGUEDE, "Accelerated degradation of yttria stabilized zirconia electrolyte during high-temperature water electrolysis" , J. Solid State Electrochem. 23 (2019) 871-881.

[5] A. GRISHIN, M. BEN OSMAN, H. MESKINE, V. ALBIN, V. LAIR, M. CASSIR, A. RINGUEDE, "Deeper Understanding of Ternary Eutectic Carbonates/Ceria-Based Oxide Composite Electrolyte through Thermal Cycling", Energies 15 (2022) 2688.

7. PhD student's workload necessary to achieve the learning outcomes**

No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	15
2	Hours of consultations with the academic teacher, exams, tests, etc.	5
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	5

4	Amount of time devoted to the preparation for exams, test, assessments	5
	Total number of hours	**30**
	ECTS credits	**1**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	1
Number of ECTS credits earned by a student in a practical course	1