Course Name						
INTRODUCTION TO ELECTROMETALLURGY						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET 477E	7	2	4	2	-	-

Department/Program	Metallurgical and Materials Engineering		
Course Type	Elective	**Course Language**	English
Course Prerequisites	MET 213E		

Course Category by Content, %	**Basic Sciences**	**Engineering Science**	**Engineering Design**	**General Education**
		40	60	

Course Description	Introduction to Electrometallurgy, Electrochemical principles and basic concepts, Important milestones in the development of electrometallurgy, Conductivity, Electrolytic conduction, Molar conductivity, Transport numbers, Chemical changes in electrolysis, Examples of electrolysis, Electrode reactions, Stoichiometry of electrolysis (Faraday's Laws), Concentration changes in aqueous electrolytes, Galvanic cells, Electrochemical series, Redox half-cells, Kinetics of electrode reactions, Potentiometric cells, Reversible conditions, Standard Hydrogen Electrode, Potentials and thermodynamics of cells, Decomposition potential, Overpotential, Anodic oxidation, Cathodic reduction, Cementation, Electrocrystallization, Eh-pH diagrams, Technological applications; Leaching, Precipitation, Metal extraction and refining, Electrorefining and Electrowinning of metals, Fused salt electrolysis of aluminum and magnesium, Electroplating, Electroforming, Electrochemical polishing, Batteries, Fuel cells.
Course Objectives	It is the aim of this course to teach the following topics with in-depth analysis of the chemical principles, beneath the related subjects, and with numerous example problems covering the subject materials in the field of electrometallurgy. To describe the principles and practice of electrometallurgical and other electrochemical processes, which are used in the production of metals.
Course Learning Outcomes	Upon completion of this course, a student should be able to: 1. Have a detailed knowledge and understanding of some of the existing electrometallurgical processes, having learned the underlying principles, 2. Have developed skills in analyzing those existing processes which they can also use to conceive and conceptually design novel processes, and 3. Be aware of sources of further relevant information.
Textbook	Fundamental Aspects of Electrometallurgy, 2002, Popov K.I., Djokić S.S., Grgur B.N., Kluwer Academic/Plenum Publishers, New York.
Other References	• Free, M., Moats, M., Robinson, T., Neelameggham, N., Houlachi, G., Ginatta, M., Creber, D. and Holywell, G., 2012, Electrometallurgy - Now and in the Future, in Electrometallurgy, 2012 (eds. M. Free, M. Moats, G. Houlachi, E. Asselin, A. Allanore, J. Yurko and S. Wang), John Wiley & Sons, Inc., Hoboken, NJ, USA. • Djokić, S.S., 2012, Electrochemical production of metal powders, Springer Science+Business Media, NY, USA. • Rieger P.H.,1993, Electrochemistry, 2nd Ed., Chapman & Hall, NY, USA. • Pletcher D., Walsh F.C., 1993, Industrial Electrochemistry, 2nd Ed., Springer Science+Business Media, NY, USA.
Homework & Projects	Homework problems will be handed-in a week after they are assigned.
Laboratory Work	None
Computer Use	None
Other Activities	None

	Activities	Quantity	Effects on grading, %
Assessment Criteria	Midterm exams	1	20
	Quizzes	1 (min)	15
	Homework	1	15
	Projects	-	-
	Term Paper/Project		-
	Laboratory Work	-	-
	Other Activities	-	-
	Final exam	1	50

COURSE PLAN

Weeks	Topics	Course outcomes
1	Introduction to Electrometallurgy, Electrochemical principles and basic concepts, Important milestones in the development of electrometallurgy, Electrolytic conduction, Molar conductivity, Transport numbers	1, 2
2	Chemical changes in electrolysis, Examples of electrolysis, Electrode reactions	1, 2
3	Stoichiometry of electrolysis (Faraday's Laws), Concentration changes in aqueous electrolytes	1, 2
4	Galvanic cells, Electrochemical series, Redox half-cells	1, 2
5	Kinetics of electrode reactions, Potentiometric cells, Reversible conditions	1, 2
6	Standard Hydrogen Electrode, Potentials and thermodynamics of cells	1, 2
7	Decomposition potential, Overpotential	1, 2
8	Anodic oxidation, Cathodic reduction, Cementation, Electrocrystallization	1, 2
9	Eh-pH diagrams	1, 2
10	Technological Applications; Leaching, Precipitation	1-3
11	Metal extraction and refining, Electrorefining and Electrowinning of metals	1-3
12	Fused salt electrolysis of Aluminum and Magnesium, Rare Earth Metal Production by Molten Salt Electrolysis	1-3
13	Electroplating, Electrochemical polishing, Electroforming	1-3
14	Batteries, Fuel cells	1-3

Relationship between the Course and Metallurgical and Materials Engineering Curriculum

	Student Outcomes	Level of Contribution		
		1	2	3
1	Ability to apply the knowledge of mathematics, science, and engineering principles to solve problems in metallurgical and materials engineering (ABET:a)		**X**	
2	Ability to characterize materials using standard and/or self designed experimental methods and to evaluate the results (ABET:b)			**X**
3	Ability to design a system or a process, taking into consideration of the desired specifications, quality, ethics and environment (ABET:c)			
4	Ability to communicate both orally and in the written form and to take part in, and provide leadership of the teams in the elucidation of engineering problems (ABET:d, g)			
5	Ability to define, formulate and solve engineering problems in the development, production, processing, protection and usage of engineering materials (ABET:e)			**X**
6	An understanding of professional and ethical responsibilities (ABET:f)			
7	An understanding of current/contemporary issues and impact of engineering solutions in broad cultural, national and global levels (ABET:h, j)	**X**		
8	A comprehension of the nature of engineering progress closely linked with the development of new materials and production processes. An ability to engage in life-long learning and a recognition of its necessity (ABET:i)		**X**	
9	Ability to use essential tools and techniques of modern engineering in the development, production, processing, protecting of the existing and new engineering materials (ABET:k)			**X**

1: Little, 2: Partial, 3: Full

Course relationships with major elements of the field and material classes

		Level of Contribution		
		1	2	3
MAJOR ELEMENTS OF THE FIELD	STRUCTURE		**X**	
	PROPERTIES			**X**
	DESIGN EXPERIMENT/ANALYSE DATA			**X**
	PROCESSING	**X**		
	COST/PERFORMANCE	**X**		
	QUALITY/ENVIRONMENT			**X**
	DESIGN PROCESS OR PRODUCT		**X**	
MATERIAL CLASSES	METAL			**X**
	CERAMICS			
	POLYMERS			
	COMPOSITES			

1: Little, 2: Partial, 3: Full

Prepared by	**Date**	**Signature**
Prof.Dr. Cüneyt ARSLAN Prof.Dr. Sebahattin GÜRMEN	March, 2013	