Course Name						
CHEMICAL METALLURGY II						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET 326E	6	2,5	4	2	1	-

Department/Program	Metallurgical and Materials Engineering		
Course Type	Compulsory	**Course Language**	English
Course Prerequisites	MET 313E		

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

Course Description	Technological applications in pyrometallurgy, Chloridizing, sulfatizing, oxidizing, and sinter roasting, Alkaline roasting, selective vaporization, selective decomposition, calcination. Slag forming and smelting, Matte forming and smelting, Reduction, Reduction with non-metallic compounds Reducing melting operations, Reducing melting and vaporization operations, Reduction in molten state Metallothermic reductions, Pyrometallurgical rafination operations. Technological applications in hydrometallurgy. Dissolution operations, All leaching processes. Solution processing, Crystallization. Precipitation, Precipitation with chemical additives, Precipitation with gases, Selective precipitation under pressure, Total precipitation under pressure, Solvent Extraction, General concepts, McCabe-Thiele Diagrams, Applications. Technological applications in electrometallurgy Cementation, Aqueous electrowinning. Electrolytic reduction, Electrolytic rafination, Electrolytic plating, Electrochemical surface finishing. Molten salt electrolysis.
Course Objectives	1. To provide fundamental concepts utilized in Metallurgical and Materials Engineering, along with examples from the real-life applications, indicating that these concepts are not just “notions” but must be recognized as a whole. 2. To teach all the methods and processes in extractive metallurgy employed on the route “from ore to metal”, in a manner of providing an infrastructure for other courses.
Course Learning Outcomes	Students who pass the course will be able to: 1. Learn the general characteristics of pyrometallurgical processes; chlorination, sulfatizing, oxidizing, sinter roasting, alkaline roasting, selective vaporization, selective decomposition, calcination, matte forming/smelting, slag forming/smelting, reduction and reduction with non-metallic compounds. 2. Understand reducing melting operations, reducing vaporization operations, reduction in molten state, metallothermic reduction (aluminothermy, silicothermy, magnesiothermy). 3. Know pyrometallurgical rafination operations, fire rafination of copper, segregation and drossing, rafination in gaseous state, zone rafination. 4. Comprehend the main characteristics of hydrometallurgy**;** dissolution operations, in-situ leach, heap leach, percolation leach, pressure leach, solution processing, crystallization. 5. Learn precipitation with chemical additives, precipitation with gases, selective precipitation under pressure, total precipitation under pressure, solvent Extraction, McCabe-Thiele diagrams and applications, reaction kinetics. 6. Identify the main characteristics of electrometallurgy**;** cementation, electrowinning, electrorefining, fused salt electrolysis, polarization diagrams.
Textbook	• C K. Gupta, Chemical Metallurgy, Wiley-Vch, 1997. • F. Habashi, Handbook of Extractive Metallurgy, Wiley-Vch, 1997.
Other References	• P. C. Hayes, Process Selection in Extractive Metallurgy, Hayes Pub. Co., 1985. • T. Rosenqvist, Principles of Extractive Metallurgy, McGraw-Hill, 1983. • B. A. Wills, Mineral Processing Technology, Pergamon Press, 1989. • J. J. Moore, Chemical Metallurgy, Butterworths, 1981. • F. Y. Bor, Ekstraktif Metalurji Prensipleri, 1 ve 2 cilt, İTÜ Matbaası, 1989. • F. Pawlek, Metallhüttenkunde, Walter de Gruyter, 1983. • İ. Duman, Kimyasal Metalurji Ders Sunuları, 2004.
Homework & Projects	-
Laboratory Work	-
Computer Use	-
Other Activities	**-**

Assessment Criteria	**Activities**	**Quantity**	**Effects on Grading, %**
	Midterm Exams	**2**	**50**
	Quizzes		
	Homework		
	Projects		
	Term Paper/Project		
	Laboratory Work		
	Other Activities		
	Final Exam	**1**	**50**

COURSE PLAN

Weeks	Topics	Course Outcomes
1	Technological applications in pyrometallurgy, Chloridizing, sulfatizing, oxidizing, and sinter roasting, Alkaline roasting, selective vaporization, selective decomposition, calcination.	1
2	Slag forming and smelting, Matte forming and smelting,	1-2
3	Reduction, Reduction with non-metallic compounds	1-2
4	Reducing melting operations, Reducing melting and vaporization operations, Reduction in molten state	1-2-3
5	Metallothermic reductions, Aluminothermy, Silicothermy, Magnesiothermy.	1-2
6	Pyrometallurgical rafination operations, Rafination via oxidation in molten state, Fire rafination of copper, Segregation and drossing, Rafination in gaseous state, Zone rafination	2-3
7	1st mid term exam	
8	Technological applications in hydrometallurgy Dissolution operations, In-situ leach, Heap leach, Percolation leach, Pressure leach, Bacterial leach,	4
9	Solution processing, Crystallization. Precipitation, Precipitation with chemical additives, Precipitation with gases, Selective precipitation under pressure, Total precipitation under pressure,	4-5
10	Solvent Extraction, General concepts, McCabe-Thiele Diagrams, Applications.	4-5-6
11	Technological applications in electrometallurgy Cementation, Aqueous electrowinning. Electrolytical reduction, Electrolytical decomposition	4-5-6
12	Electrolytical rafination, Electrolytical plating, Electrochemical surface finishing.	6
13	2nd mid term exam	
14	Molten salt electrolysis, Electrothermal operations	6

Relationship between the Course and METALLURGICAL AND MATERIALS ENGINEERING **Curriculum**

	Program 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)			X
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)			X
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)		X	
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 ELEMENT OF THE FIELDS	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			X
	POLYMERS		X	
	COMPOSITES		X	

1: Little, 2. Partial, 3. Full

Prepared by	**Date**	**Signature**
Prof. Dr. Onuralp Yücel	March, 2013	