Course Name						
CHEMICAL METALLURGY II						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET 326E	6	2.5	5	2	1	-

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

Course Category by Content, %	**Basic Sciences**	**Engineering Science**	**Engineering Design**	**General Education**
	-	40	40	20

Course Description	Technological Applications in Pyrometallurgy, Copper Metallurgy, Mines and Smelters, Comminution and Froth Flotation, Matte Smelting, Copper Matte and Slags, Matte Smelting Furnaces, Coppermaking Reactions, Converting, Fire Refining and Anode Casting, Direct Blister Flash Smelting, Zinc Pyrometallurgy, Imperial Smelting Process, Waelz Kiln Process, Slag Fuming Reactors, Pyrometallurgical Zinc Refining, Lead Pyrometallurgy, Sintering-Reduction Processes, Direct Smelting-Reduction Processes, Secondary Processes, Pyrometallurgical Lead Refining Processes. Steel Value Chain, Iron Mines and Smelters in The World, Iron Ores and Ore Dressing, Sintering, Pelletizing, Integrated Iron and Steel Production, Coke making, Hot Metal Pre-treatment, Basic Oxygen Steelmaking, Thermochemical Reactions in Steel Processes, Secondary Metallurgy (Ladle Refining), Continuous Casting Process, EAF Steelmaking. 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 learn: 1. The general characteristics of pyrometallurgical processes; matte forming/smelting, slag forming/smelting, reduction and reduction with non-metallic compounds. 2. Reducing melting operations, reducing vaporization operations, reduction in molten state, 3. Pyrometallurgical refining operations, 4. The main characteristics of hydrometallurgy; dissolution operations, in-situ leach, heap leach, percolation leach, pressure leach, solution processing, crystallization. 5. 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. The main characteristics of electrometallurgy; cementation, electrowinning, electrorefining, fused salt electrolysis, polarization diagrams.
Textbook	1. C K. Gupta, Chemical Metallurgy, Wiley-Vch, 1997. 2. F. Habashi, Handbook of Extractive Metallurgy, Wiley-Vch, 1997.
Other References	1. P. C. Hayes, Process Selection in Extractive Metallurgy, Hayes Pub. Co., 1985. 2. T. Rosenqvist, Principles of Extractive Metallurgy, McGraw-Hill, 1983. 3. B. A. Wills, Mineral Processing Technology, Pergamon Press, 1989. 4. J. J. Moore, Chemical Metallurgy, Butterworths, 1981. 5. F. Y. Bor, Ekstraktif Metalurji Prensipleri, 1 ve 2 cilt, İTÜ Matbaası, 1989. 6. F. Pawlek, Metallhüttenkunde, Walter de Gruyter, 1983.
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	Copper Metallurgy, Copper Mines and Smelters in The World, Comminution and Froth Flotation, Matte Smelting, Copper Matte and Slags	1
2	Matte Smelting Furnaces, Coppermaking Reactions, Converting, Fire Refining and Anode Casting, Direct Blister Flash Smelting	1,2
3	Zinc Pyrometallurgy, Zinc Mines and Smelters in The World, Imperial Smelting Process, Waelz Kiln Process, Slag Fuming Reactors, Pyrometallurgical Zinc Refining,	1,2
4	Lead Pyrometallurgy, Lead Mines and Smelters, Sintering-Reduction Processes, Direct Smelting-Reduction Processes, Secondary Processes, Pyrometallurgical Lead Refining	1,2,3
5	Steel Value Chain, Iron Mines and Smelters in The World, Iron Ores and Ore Dressing, Sintering, Pelletizing, Integrated Iron and Steel Production, Coke making	1,2
6	Hot Metal Pre-treatment, Basic Oxygen Steelmaking, Thermochemical Reactions in Steel Processes, Secondary Metallurgy, Continuous Casting Process, EAF Steelmaking.	2,3
7	Hot Metal Pre-treatment, Basic Oxygen Steelmaking, Thermochemical Reactions in Steel Processes, Secondary Metallurgy, Continuous Casting Process, EAF Steelmaking.	2,3
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	Electrolytical rafination, Electrolytical plating, Electrochemical surface finishing.	6
14	Molten salt electrolysis, Electrothermal operations	6

Relationship between the Course and Metallurgical and Materials Engineering Curriculum

	Student Outcomes	Level of Contribution		
		1	**2**	**3**
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering science and mathematics	**X**		
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare as well as global, cultural, social, environmental and economic factors			**X**
3	An ability to communicate effectively with a range of audiences	**X**		
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts			**X**
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	**X**		
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions	**X**		
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies		**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 AND GLASS			**X**
	POLYMER		**X**	
	COMPOSITES		**X**	
	BIOMETARIALS		**X**	

1: Little, 2: Partial, 3: Full

Prepared by	**Date**	**Revision #**	**Signature**
Prof. Dr. Onuralp YÜCEL Prof. Dr. C. Bora DERİN Assoc. Prof. Dr. M. Şeref SÖNMEZ	December 2020		