Course Name								
Modeling and Simulation of Metallurgical Processes								
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**				
				Theoretical		**Tutorial**		**Laboratory**
MET 473	7	3	5	3		-		-
Department/Program	Metallurgical and Materials Engineering Department							
Course Type	Elective			**Course Language**		Turkish		
Course Prerequisites	-							
Course Category by Content, %	**Basic Sciences**		**Engineering Science**		**Engineering Design**		**General Education**	
			60 %		40 %			
Course Description	Examples of metallurgical processes, their mass and energy balances, and simultaneous solutions; Fundamentals of modeling and simulation, in-class demonstration of modeling software; Description of certain extractive metallurgical processes (roasting, smelting, leaching, precipitation, electrolysis, refining, etc.) and steps of their mathematical modeling; Concepts of kinetics, batch, and continuous processes in extractive metallurgy; Determining the effect of controlling parameters, such as particle size, temperature, concentration, pressure, gas/liquid/solid flow rate, stirring speed, current density, etc., and mathematical modeling thereof; Assigning these parameters to the student groups as term projects; Hands-on experimenting of modeling software in the computer-lab to investigate the effect of these parameters, individually assigned to the groups of students; Building the models of metallurgical processes, investigated under the light of related controlling parameters, their simulation with modeling software, in-class presentation of these models by the student groups to their classmates; Additionally, a website, called steeluniversity.org, is an "industry-university" delivering education and training to current and future employees of steel companies and related businesses. The goal of steeluniversity.org is to inspire and motivate students and steel industry people by providing a suite of learning opportunities to gain more knowledge of how steel is made, how it is used in consumer products. The steeluniversity.org website delivers a comprehensive package of online learning for steel manufacturing, steel metallurgy, steel applications, environment and safety. The learning content is delivered in an interactive and informative way providing an opportunity to study and apply the basic scientific, metallurgical and engineering principles, thermodynamics and kinetics that underpin the production and use of steel. It contains a series of realistic, game-like simulations of the main steelmaking operations which can and will be used throughout the semester in competition mode, between the team of students.							
Course Objectives	1. Description of metallurgical processes and some simple simulation exercises, 2. Fundamentals of simulation and modeling, 3. Advances in theoretical background of metallurgical processes' simulation and modeling, 4. Demonstrating a sample commercial simulation program, 5. To have the students research on the effect of certain parameters on metallurgical processes with the help of modeling software.							
Course Learning Outcomes	Upon completion of this course, a student should be able to: • Understand the importance and necessity of simulation and modeling studies in metallurgical processes, • Comprehend the data processing and process control, • Improve his/her theoretical background on simulation and modeling of metallurgical systems, • Support his/her theoretical background by hands-on application on a modeling software, • Be aware of the resulting innovations by applying simulation and modeling software, • Create a model of a given metallurgical process by considering the related control parameters.							
Textbook	R. Peter King, "Modeling and Simulation of Mineral Processing Systems", ISBN:0-7506-4884-8, 2001.							
Other References	• B.A. Ogunnaike, Process Dynamics, Modeling, and Control, ISBN: 0-19-509119-1, 1994. • R.I.L. Guthrie, Engineering in Process Metallurgy, ISBN: 0-19-856367-1, 1993. • Transport and Chemical Rate Phenomena, N.J. Themelis, Gordon & Breach, New York, 1995. • C. Arslan, Modeling the Performance of Aqueous Chromium Electrowinning Cells, Ph.D. Thesis, Columbia University, New York, 1991. • E. Peters, D. Dreisinger, Mixing, Leaching and Modeling Course Notes, Metals and Materials Eng. Dept. Univ. of British Columbia, Vancouver, Canada, 1990. • R.G. Bautista, R.J. Wesely, G.W. Warren, Hydrometallurgical Reactor Design and Kinetics, A Publication of The Metallurgical Society, Inc., U.S.A., 1986. • A.W. Bryson, Modeling the Performance of Electrowinning Cells, Proceedings Hydrometallurgy 81, Manchester 1981, pp.G2/1-G2/11, 1981.							
Homework & Projects	Within the context of this course, each student group is assigned with a metallurgical process and is expected to model that process through the semester with the help of software (Ansys, Apen Plus, Comsol Multiphysics, CadsimPlus, etc.). Groups will present their model in front of their classmates, at the end of the semester.							
Laboratory Work								
Computer Use	Students are required to utilize one of the modeling programs that exist on university's mainframe.							
Other Activities								
Assessment Criteria			**Quantity**	**Effects on Grading, %**				
	Activities		**-**	**-**				
	Midterm Exams		**1 (min)**	**25 %**				
	Quizzes		**-**	**-**				
	Homework		**-**	**-**				
	Projects		**-**	**-**				
	Term Paper/Project		**1 (min)**	**30 %**				
	Laboratory Work		**-**	**-**				
	Other Activities		**-**	**-**				
	Final Exam		**1**	**45 %**				

COURSE PLAN

Weeks	Topics	Course Outcomes
1	Examples of metallurgical processes, their mass and energy balances, and simultaneous solutions.	1, 2
2	Examples of metallurgical processes, their mass and energy balances, and simultaneous solutions.	1, 2
3	Fundamentals of modeling and simulation, in-class demonstration of modeling software.	1-4
4	Fundamentals of modeling and simulation, in-class demonstration of modeling software.	1-4
5	Description of certain extractive metallurgical processes (roasting, smelting, leaching, precipitation, electrolysis, refining, etc.) and steps of their mathematical modeling.	2, 3
6	Description of certain extractive metallurgical processes (roasting, smelting, leaching, precipitation, electrolysis, refining, etc.) and steps of their mathematical modeling.	2, 3
7	Description of certain extractive metallurgical processes (roasting, smelting, leaching, precipitation, electrolysis, refining, etc.) and steps of their mathematical modeling.	2, 3
8	Concepts of kinetics, batch, and continuous processes in extractive metallurgy.	1-3
9	Determining the effect of controlling parameters, such as particle size, temperature, concentration, pressure, gas/liquid/solid flow rate, stirring speed, current density, etc., and mathematical modeling thereof. Assigning these parameters to the student groups as term projects.	4-6
10	Hands-on experimenting of modeling software in the computer-lab to investigate the effect of these parameters, individually assigned to the groups of students.	4-6
11	Hands-on experimenting of modeling software in the computer-lab to investigate the effect of these parameters, individually assigned to the groups of students.	4-6
12	Building the models of metallurgical processes, investigated under the light of related controlling parameters, their simulation with modeling software, in-class presentation of these models by the student groups to their classmates.	4-6
13	Building the models of metallurgical processes, investigated under the light of related controlling parameters, their simulation with modeling software, in-class presentation of these models by the student groups to their classmates.	4-6
14	Building the models of metallurgical processes, investigated under the light of related controlling parameters, their simulation with modeling software, in-class presentation of these models by the student groups to their classmates.	4-6

Relationship between the Course and Metallurgical & 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)			
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 and surface treatment 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			
	POLYMERS			
	COMPOSITES			

1: Little, 2. Partial, 3. Full

Prepared by	Date	**Signature**
Prof.Dr. Cüneyt ARSLAN Doç.Dr. Sebahattin GÜRMEN	25.12.2009	