Course Name						
MODELLING AND SIMULATION OF METALLURGICAL AND MATERIALS PROCESSING						
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Course Implementation, Hours/Week**		
				Theoretical	**Tutorial**	**Laboratory**
MET 346E	6	2	3	2	-	-
Department/Program	Metallurgical and Materials Engineering Department					
Course Type	Required			**Course Language**	English	
Course Prerequisites	None					
Course Category by Content, %	**Basic Sciences**	**Engineering Science**		**Engineering Design**	**General Education**	
		60		40		
Course Description	Introduction to modelling & simulation, Basic principles of modelling & simulation, Mathematical and physical basis of modeling & its methodology, Basic approaches and techniques of modelling & simulation, Examples of metallurgical and materials processes, Mass and energy balances, and simultaneous solutions, In-class demonstration of modelling software, Modeling and Simulation in Materials Science, Application of the methodology for materials behavior and processing problems, Modeling of structural materials, Description of certain metallurgical processes (roasting, smelting, leaching, precipitation, electrolysis, refining, etc.) and steps of their mathematical modelling and approaches, Concepts of batch, and continuous processes in metallurgy, Determining the effect of controlling parameters, such as composition, temperature, particle size, concentration, pressure, gas/liquid/solid flow rate, stirring speed, current density, etc., and mathematical modelling thereof. Assigning these parameters to the student groups as term projects, Hands-on experimenting of modelling software in the computer-lab to investigate the effect of these parameters, individually assigned to the groups of students, Building the models of metallurgical and materials processes, investigated under the light of related controlling parameters, Their simulation with modelling software, In-class and in a competition style presentation of these models by the student groups, to their classmates.						
Course Objectives	1. Description of metallurgical and materials processes and some simulation applications, 2. Fundamental principles, methods, and approaches of simulation and modelling, 3. Developing the theoretical background of metallurgical processes' simulation and modelling, 4. Demonstrating a sample commercial simulation program, 5. To have the students search for the effect of certain parameters on metallurgical processes with the help of modelling software and have them evaluate engineering problems with different techniques.					
Course Learning Outcomes	Upon successful completion of this course, a student should be able to: 1. Understand the importance and necessity of simulation and modelling studies in metallurgical and materials processes, 2. Comprehend the data processing and process control, 3. Improve his/her theoretical background on simulation and modelling of metallurgical and materials processes, 4. Support his/her theoretical background by hands-on application on a modelling software, 5. Be aware of the resulting innovations by applying simulation and modelling software, 6. Create a model of a given metallurgical process by considering the related control parameters.					
Textbook	• Barber Z.H., 2005, "Introduction of Materials Modeling", Maney Publishing. • King P.R., 2001, "Modeling and Simulation of Mineral Processing Systems", ISBN:0-7506-4884-8.					
Other References	• Mosterman P. J.,2013, "Realtime simulation technologies: principles, methodologies, and applications", (Eds. Popovici K., Mosterman P. J.), Taylor & Francis Group, LLC., CRC Press, Boca Raton, FL, USA. ISBN : 978-1-4398-4665-0. • Ghasem N., 2012, "Computer methods in chemical engineering", Taylor & Francis Group, LLC., CRC Press, Boca Raton, FL, USA. ISBN : 978-1-439-84999-6. • Guo X.Z. (Ed.), 2007, "Multiscale Materials Modelling: Fundamental and Applications", Woodhead Publishing Limited, Cambridge. • Raabe D., 1998, "Computational Materials Science", Wiley VCH Verlag GmbH. • Ogunnaike B.A., 1994, "Process Dynamics, Modelling, and Control", ISBN: 0-19-509119-1994. • Arslan C., 1991, "Modelling the Performance of Aqueous Chromium Electrowinning Cells",					

	Ph.D. Thesis, Columbia University, New York. • Peters E., Dreisinger D., 1990, "Mixing, Leaching and Modelling Course Notes", Metals and Materials Eng. Dept., Univ. of British Columbia, Vancouver, Canada. • Bautista G.R., Wesely J.R., Warren W.G., 1986, "Hydrometallurgical Reactor Design and Kinetics", A Publication of The Metallurgical Society, Inc., U.S.A. • Bryson W.A., 1981, "Modelling the Performance of Electrowinning Cells", Proceedings Hydrometallurgy 81, Manchester 1981, pp.G2/1-G2/11.
Homework & Projects	Within the course content, the students will get acquainted with and learn to use modeling and simulation software. Teams of students will demonstrate their assigned simulations to their classmates, during the final week of the course, in a competition mode.
Laboratory Work	
Computer Use	Along with the modeling and simulation software (HSC 9.03, MSC APEX, MSC MARC, Comsol Multiphysics) the simulations at www.steeluniversity.org will also be utilized.
Other Activities	

Assessment Criteria	**Activities**	**Quantity**	**Effects on Grading, %**
	Midterm Exams	1	35
	Quizzes		
	Homework		
	Projects		
	Term Paper/Project	1	15
	Laboratory Work		
	Other Activities		
	Final Exam	1	50

COURSE PLAN

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

	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)			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)			
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	