Course Name						
FUNDAMENTALS OF METALLURGICAL THERMODYNAMICS						
				Course Implementation, Hours/Week		
Code	**Semester**	**Local Credits**	**ECTS Credits**	**Theoretical**	**Tutorial**	**Laboratory**
MET 215E	3	2,5	3	2	1	-

Department/Program	Metallurgical and Materials Engineering		
Course Type	Required	**Course Language**	English
Course Prerequisites	None		

Course Category by Content, %	**Basic Sciences**	**Engineering Science**	**Engineering Design**	**General Education**
		80	20	

Course Description	The first law of thermodynamics, enthalpy, heat capacity, heat of reaction, combustion and fuels, flame temperature, second law of thermodynamics, entropy and the criterion for equilibrium, third law of thermodynamics, variation of entropy as a function of temperature, free energy, equilibrium in thermodynamic systems, phase equilibrium in a one-component system, standard Gibbs free energy change, equilibrium constant, oxidation reactions, Ellingham diagrams, reduction of oxides.
Course Objectives	1. To provide students to understand basic concepts of thermodynamics and importance in metallurgical and materials engineering. 2. To provide students to understand importance of energy and energy saving in metallurgical and materials engineering. 3. To provide students to perform thermodynamic calculations for basic metallurgical and materials engineering processes 4. To provide students to use thermodynamic in the selection of processes in metallurgical and materials engineering.
Course Learning Outcomes	Students who pass the course will be able to: 1. Using the first law of thermodynamics, under constant pressure calculate enthalpy change(=heat energy) of a substance or reaction with changing temperature, 2. Calculate optimum combustion conditions of a fuel, 3. Calculate energy balance in basic metallurgical and materials engineering processes, 4. Using second and third law of thermodynamics; calculate change of entropy as a function of temperature, 5. Examine phase equilibrium in a one-component systems by means of free energy 6. Calculate thermodynamic equilibrium conditions of systems and to determine whether a chemical reaction is thermodynamically possible. 7. Calculate the equilibrium composition of reactions. 8. Ability to determine oxygen, sulphur, etc. affinity of metals and compare stability of metal oxides, sulphids with each other. 9. Ability to select proper reductant and temperature for processes.
Textbook	• Aytekin, V., “Metalurji Termodinamiği”, İ.T.Ü. Metalurji Fakültesi Ofset Baskı Atelyesi, İstanbul 1980. • Gaskel, D. R. “Introduction to the Thermodynamics of Materials”, Taylor & Francis, Third Edition, 2003
Other References	• Dikeç, F., Aydın, S., “Çözümlü Metalurji Termodinamiği Problemleri” İ.T.Ü. Kimya-Metalurji Fakültesi Ofset Atölyesi, İstanbul, 1991. • DeHoff, R.T., “Thermodynamics in Materials Science”, McGraw-Hill,1993 . • Ragone, D.V. “Thermodynamics of Materials”, John Wiley & Sons, Inc.,1995. • Kubaschewski, O., Alcock,C.B.,Spencer,P.J., “Materials Thermochemistry”, Pergamon Press, New York, 1993. • Bodswort, C., Appleton, A.S., “Problems in Applied Thermodynamics”, Lonnmans, London, 1965.
Homework & Projects	• Group projects about the main chapters are given • Homework (every week) are given for better understanding the lecture and to be ready for the following week.
Laboratory Work	**NONE**
Computer Use	• The projects should be prepared using computer, especially all of the graphics should be plotted using excel or similar software. End of the first lecture a crash Excel course is given.
Other Activities	

Assessment Criteria	**Activities**	**Quantity**	**Effects on Grading, %**
	Midterm Exams	2	40
	Quizzes	-	-
	Homework	MIN 10	-
	Projects	MIN 4	10
	Term Paper/Project	-	-
	Laboratory Work	-	-
	Other Activities	-	-
	Final Exam	1	50

COURSE PLAN

Weeks	Topics	Course Outcomes
1	Thermodynamic definitions, thermodynamic state equations, energy types, reversible and non reversible reactions	1
2	I. Law of thermodynamics, enthalpy, heat capacity, Kirchhoff equation	1
3	Heat of reaction, Hess Law, temperature dependency of heat of reaction	1,2
4	Combustion and fuel, adiabatic flame temperature	1,2
5	Energy balance	1,2,3
6	I. Mid-term	
7	II. Law of thermodynamics, entropy, III. Law of thermodynamics, variation of entropy as a function of temperature	4
8	Free energy, determination of equilibrium conditions	4
9	Phase equilibrium in a one-component system	5
10	Standard free energy, equilibrium constant, calculation of composition of reaction under equilibrium conditions	6
11	Reactions between gases and pure condensed matter, oxidation reactions	6,7
12	Ellingham diagrams	7,8
13	Reduction reactions	6,7,8,9
14	2. Mid-term	

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)			
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)		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)			
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)			

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			
	PROPERTIES			
	DESIGN EXPERIMENT/ANALYSE DATA			
	PROCESSING			**x**
	COST/PERFORMANCE	**x**		
	QUALITY/ENVIRONMENT			
	DESIGN PROCESS OR PRODUCT		**x**	
MATERIAL CLASSES	METAL			**x**
	CERAMICS		**x**	
	POLYMERS			
	COMPOSITES			

1: Little, 2. Partial, 3. Full

Prepared by	Date	**Signature**
Assist. Prof. Dr. Nuri SOLAK	March 2013	