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	1. Aytekin, V., “Metalurji Termodinamiği”, İ.T.Ü. Metalurji Fakültesi Ofset Baskı Atelyesi, İstanbul 1980. 2. Gaskel, D. R. “Introduction to the Thermodynamics of Materials”, Taylor & Francis, Third Edition, 2003						
Other References	1. Dikeç, F., Aydın, S., “Çözümlü Metalurji Termodinamiği Problemleri” İ.T.Ü. Kimya-Metalurji Fakültesi Ofset Atölyesi, İstanbul, 1991. 2. DeHoff, R.T., “Thermodynamics in Materials Science”, McGraw-Hill,1993 . 3. Ragone, D.V. “Thermodynamics of Materials”, John Wiley & Sons, Inc.,1995. 4. Kubaschewski, O., Alcock,C.B.,Spencer,P.J., “Materials Thermochemistry”, Pergamon Press, New York, 1993. 5. 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 forthe 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.						
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	1,2,3
6	Energy balance-2	1,2,3
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-1	6,7,8,9
14	Reduction reactions-2	6,7,8,9

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, analyse 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			
	PROPERTIES			
	DESIGN EXPERIMENT/ANALYSE DATA			
	PROCESSING			x
	COST/PERFORMANCE	x		
	QUALITY/ENVIRONMENT			
	DESIGN PROCESS OR PRODUCT		x	
MATERIAL CLASSES	METAL			x
	CERAMICS AND GLASS		x	
	POLYMERS			
	COMPOSITES			
	BIOMATERIALS			

1: Little, 2. Partial, 3. Full

Prepared by	Date	Revision #	Signature
Assist. Prof. Dr. Nuri SOLAK	December 2020		