NE 204 MATERIALS THERMODYNAMICS

Course Code	Course Name			Semester	
NE 204	Materials Thermodynamics			Fall ☐ Spring ☒ Summer ☐	
Hours				Credit	ECTS
Theory	Practice	Lab		3	5
3	0	0			

Course Details	
Department	Nanotechnology Engineering
Course Language	English
Course Level	Undergraduate ☒ Graduate ☐
Mode of Delivery	Face to Face ☒ Online ☐ Hybrid ☐
Course Type	Compulsory ☒ Elective ☐
Course Objectives	Learning the fundamentals of thermodynamics in materials science, driving general thermodynamic equations, understanding equilibrium, phase diagrams, applying thermodynamics to ideal gases, solutions, polymers and relating thermodynamics & transport phenomena.
Course Content	Materials Thermodynamics introduces the fundamental principles of classical thermodynamics with a focus on their application to metallurgical systems. The course covers the basic concepts of thermodynamic systems, properties, and equilibrium, followed by the first, second and third laws of thermodynamics, including internal energy, enthalpy, entropy, and their relevance to energy changes in chemical and phase transformations. It further explores Gibbs and Helmholtz free energies, Maxwell's relations, and the criteria for spontaneity and equilibrium. Finally, it introduces the thermodynamics of solutions, activities, partial molar quantities, and phase equilibria relevant to alloy systems, in addition adiabatic flame temperature calculations, laying the groundwork for understanding phase diagrams and metallurgical reaction feasibility.
Course Method/ Techniques	Lecture ☒ Question & Answer ☒ Presentation ☐ Discussion ☒
Prerequisites/ Corequisites	Calculus I, Chemistry I-II
Work Placement(s)	No work placements

Textbook/References/Materials
• Introduction to the Thermodynamics of Materials, 6th Edition, Gaskell & Laughlin, CRC Press. • Thermodynamics of Materials, Volume I, David Ragone, MIT Series.

Course Category				
Mathematics and Basic Sciences	☐		Education	☐
Engineering	☐		Science	☐
Engineering Design	☐		Health	☐
Social Sciences	☐		Profession	☐

Weekly Schedule

No	Topics	Materials/Notes
1	Introduction, Concept of States, Units of Energy and Work, Intensive & Extensive Variables.	Gaskell
2	Introduction to 0th, 1st, 2nd and 3rd Law of Thermodynamics.	Gaskell
3	1st Law of Thermodynamics: heat, work, isentropic, isobaric, isotropic ideal gas processes and reversible, irreversible work concepts.	Gaskell
4	1st Law of Thermodynamics: magnetic work, electrical work.	Gaskell
5	2nd Law of Thermodynamics: spontaneous processes, maximum work, reversible & irreversible isothermal & adiabatic expansion &compression.	Gaskell
6	2nd Law of Thermodynamics: spontaneous processes, maximum work, reversible & irreversible isothermal & adiabatic expansion &compression.	Gaskell
7	Revision of 0th, 1st and 2nd Laws.	Gaskell
8	MIDTERM	
9	Fundamental Equations and Their Relationships, Maxwell's Relations.	Gaskell
10	Fundamental Equations and Their Relationships, Maxwell's Relations.	Gaskell
11	Heat Capacity, Enthalpy, Entropy, 3rd Law of Thermodynamics.	Gaskell
12	Heat Capacity, Enthalpy, Entropy, 3rd Law of Thermodynamics.	Gaskell
13	Heat Capacity, Enthalpy, Entropy, 3rd Law of Thermodynamics.	Gaskell
14	Introduction to Phase Equilibria.	Gaskell

15	Introduction to Phase Equilibria.	Gaskell
16	FINAL	

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance	14	**5 %**
Lab	--	--
Practice	--	--
Fieldwork	--	--
Course-specific internship	--	--
Quiz/Studio/Criticize	1	**5 %**
Homework	6	--
Presentation / Seminar	0	-
Project	0	-
Report	0	--
Seminar	--	--
Midterm Exam	1	**40 %**
Final Exam	1	**50 %**
	Total	**100%**
Contribution of Midterm Studies to Success Grade		50 %
Contribution of End of Semester Studies to Success Grade		50 %
	Total	**100%**

ECTS Allocated Based on Student Workload			
Activities	**Quantity**	**Duration (Hrs)**	**Total Workload**
Course Hours	14	3	42
Lab	0	0	0
Practice	0	0	0
Fieldwork	0	0	0
Course-specific Work Placement	0	0	0
Out-of-class study time	10	5	50
Quiz/Studio/Criticize	1	1	1
Homework/Attendance	6	3	18
Presentation / Seminar	0	0	0
Project	0	0	0
Report	0	0	0
Midterm Exam and Preparation for Midterm	1	5	5
Final Exam and Preparation for Final Exam	1	10	10
Total Workload			**126**
Total Workload / 25			**126/25**
ECTS Credit			**5.04 ≅ 5**

Course Learning Outcomes

No	Outcome
L1	Understand and apply the fundamental laws of thermodynamics (zeroth, first, second, third laws) to analyze energy transformations in metallurgical systems.
L2	Calculate thermodynamic properties such as internal energy, enthalpy, entropy, and Gibbs free energy for ideal and real substances involved in metallurgical processes.
L3	Evaluate the spontaneity and feasibility of chemical and phase reactions using criteria based on free energy and equilibrium conditions.
L4	Analyze thermochemical data to determine heat effects in reactions, including heats of formation, reaction, mixing, and adiabatic flame temperatures.
L5	Interpret and apply the concepts of solution thermodynamics and phase equilibria, including chemical potential, activity, and the Gibbs phase rule, in the context of alloy and metallurgical systems.

Contribution of Course Learning Outcomes to Program Competencies/Outcomes

Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant

	PO-1		PO-2		PO-3		PO-4		PO-5			PO-6			PO-7						PO-8		PO-9		PO-10			PO-11		Total
#	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	5.3	6.1	6.2	6.3	7.1	7.2	7.3	7.4	7.5	7.6	8.1	8.2	9.1	9.2	10.1	10.2	10.3	11.1	11.2	#
L1	5	5												3	5	5														23
L2	5	5					5	5						3	5	5														33
L3	5	5	4											3	5	5														27
L4	5	5					5	5						3	5	5														33
L5	5	5	4				5	5						3	5															32
																													Total=	148

#	PROGRAM ÇIKTILARI ve ALT BİLEŞENLERİ
1.1.	Matematik, fen bilimleri ve ilgili mühendislik disiplinine özgü konularda yeterli bilgi birikimi; Adequate knowledge in mathematics, science and subjects specific to the relevant engineering discipline;
1.2.	Bu alanlardaki kuramsal ve uygulamalı bilgileri, karmaşık mühendislik problemlerinin çözümünde kullanabilme becerisi. Ability to use theoretical and applied knowledge in these areas to solve complex engineering problems.
2.1.	Karmaşık mühendislik problemlerini tanımlama, formüle etme ve çözme becerisi; Ability to identify, formulate and solve complex engineering problems;
2.2.	Bu amaçla uygun analiz ve modelleme yöntemlerini seçme ve uygulama becerisi. Ability to select and apply appropriate analysis and modeling methods for this purpose.
3.1.	Karmaşık bir sistemi, süreci, cihazı veya ürünü gerçekçi kısıtlar ve koşullar altında, belirli gereksinimleri karşılayacak şekilde tasarlama becerisi; The ability to design a complex system, process, device or product under realistic constraints and conditions to meet specific requirements;
3.2.	Bu amaçla modern tasarım yöntemlerini uygulama becerisi. Ability to apply modern design methods for this purpose.

4.1.	Mühendislik uygulamalarında karşılaşılan karmaşık problemlerin analizi ve çözümü için gerekli olan modern teknik ve araçları seçme ve kullanma becerisi; Ability to select and use modern techniques and tools necessary for the analysis and solution of complex problems encountered in engineering practice;
4.2.	Bilişim teknolojilerini etkin bir şekilde kullanma becerisi. Ability to use information technologies effectively.
5.1.	Karmaşık mühendislik problemlerinin veya disipline özgü araştırma konularının incelenmesi için deney tasarlama, Design experiments to investigate complex engineering problems or discipline-specific research topics,
5.2.	Deney yapma, Experimentation
5.3.	Veri toplama, sonuçları analiz etme ve yorumlama becerisi. Ability to collect data, analyze and interpret results.
6.1.	Disiplin içi takımlarda etkin biçimde çalışabilme becerisi; Ability to work effectively in disciplinary teams;
6.2.	Çok disiplinli takımlarda etkin biçimde çalışabilme becerisi; Ability to work effectively in multidisciplinary teams;
6.3.	Bireysel çalışma becerisi. Ability to work individually.
7.1.	Sözlü ve yazılı etkin iletişim kurma becerisi; Ability to communicate effectively both orally and in writing;
7.2.	En az bir yabancı dil bilgisi; Knowledge of at least one foreign language;
7.3.	Etkin rapor yazma ve yazılı raporları anlama becerisi, Ability to write effective reports and understand written reports,
7.4.	Tasarım ve üretim raporları hazırlayabilme becerisi, Ability to prepare design and production reports,
7.5.	Etkin sunum yapabilme becerisi, Ability to make effective presentations,
7.6.	Açık ve anlaşılır talimat verme ve alma becerisi. Ability to give and receive clear and understandable instructions.
8.1.	Yaşam boyu öğrenmenin gerekliliği konusunda farkındalık; Awareness of the necessity of lifelong learning;
8.2.	Bilgiye erişebilme, bilim ve teknolojideki gelişmeleri izleme ve kendini sürekli yenileme becerisi. Ability to access information, to follow developments in science and technology and to continuously renew oneself.
9.1.	Etik ilkelerine uygun davranma, mesleki ve etik sorumluluk ve Acting in accordance with ethical principles, professional and ethical responsibility and
9.2.	Mühendislik uygulamalarında kullanılan standartlar hakkında bilgi. Information about standards used in engineering applications.

10.1.	Proje yönetimi, risk yönetimi ve değişiklik yönetimi gibi, iş hayatındaki uygulamalar hakkında bilgi; Knowledge of business practices such as project management, risk management and change management;
10.2.	Girişimcilik, yenilikçilik hakkında farkındalık; Awareness about entrepreneurship and innovation;
10.3.	Sürdürülebilir kalkınma hakkında bilgi. Knowledge about sustainable development.
11.1.	Mühendislik uygulamalarının evrensel ve toplumsal boyutlarda sağlık, çevre ve güvenlik üzerindeki etkileri ve çağın mühendislik alanına yansıyan sorunları hakkında bilgi; Knowledge about the effects of engineering applications on health, environment and safety in universal and social dimensions and the problems of the era reflected in the field of engineering;
11.2.	Mühendislik çözümlerinin hukuksal sonuçları konusunda farkındalık. Awareness of the legal implications of engineering solutions.