NE 305 PHASE EQUILIBRIA AND DIAGRAMS

Course Code	Course Name		Semester	
NE 305	**Phase Equilibria and Diagrams**		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 ☒ Technical Elective ☐
Course Objectives	■ In this course, the analyses of phase diagrams of materials in terms of thermodynamic variables will be discussed. Within this context, the formation of equilibrium (and non-equilibrium) microstructures for single, binary and multi component systems will be explained.
Course Content	■ **Phase Equilibria & Diagrams** is an undergraduate course that focuses on the principles governing phase stability and transformations in materials systems, particularly metals and alloys. The course introduces the concepts of phases, components, and degrees of freedom, along with the Gibbs phase rule. It covers the thermodynamic basis of phase equilibria and the interpretation of phase diagrams, including unary, binary (isomorphous, eutectic, peritectic, monotectic), and ternary systems. Students learn to read and construct equilibrium phase diagrams and use them to predict phase compositions, microstructures, and solidification behavior. The course also addresses solid solutions, intermediate phases, invariant reactions, and the role of diffusion in phase transformations, with applications in alloy design and materials processing.
Course Method/ Techniques	Lecture ☒ Question & Answer ☒ Presentation ☐ Discussion ☒

Prerequisites/ Corequisites	None.
Work Placement(s)	No work placements.

Textbook/References/Materials

- Phase Diagrams: Understanding the Basics, F.C. Campbell.
- Phase Equilibria, Phase Diagrams, Phase Transformations and their thermodynamic basis, Mats Hillert.

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

Weekly Schedule

No	Topics	Materials/Notes
1	Introduction, Unary, Binary Systems	Campbell
2	Solid Solutions and Phase Transformations	Campbell
3	Solid Solutions and Phase Transformations	Campbell
4	Thermodynamics and Phase Diagrams	Campbell
5	Thermodynamics and Phase Diagrams	Campbell
6	Isomorphous Alloy Systems	Campbell
7	Eutectic, eutectoid Alloy Systems	Campbell
8	**MIDTERM**	
9	Eutectic, eutectoid Alloy Systems	Campbell
10	Peritectic, peritectoid Alloy Systems	Campbell
11	Monotectic, monotectoid Alloy Systems	Campbell
12	Revising eutectic-oid, peritectic-oid, monotectic-oid alloy systems	Campbell
13	Solid state transformations, Iron carbon reactions	Campbell
14	Intermediate phases, phase determination	Campbell
15	Ternary Phase Diagrams, Phase determination, CALPHAD™ Discussion	Campbell
16	**FINAL**	

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance	14	--
Lab	--	--
Practice	--	--
Fieldwork	--	--
Course-specific internship	--	--
Quiz/Studio/Criticize	1	**5 %**
Homework	1	**5 %**
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	1	18	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	**Interpret and apply the Gibbs phase rule** to determine the degrees of freedom and predict phase stability in unary, binary, and ternary systems.
L2	**Analyze and construct phase diagrams**, including isomorphous, eutectic, peritectic, and monotectic systems, and use them to predict phase compositions, microstructures, and solidification behavior.
L3	**Understand the thermodynamic principles governing phase equilibria** and apply them to real materials systems for alloy design and processing decisions.

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							5	5						33
L2	5	5			5	5	5	5						3	5	5							5	5						53
L3	5	5	4											3	5	5							5	5						37
																													Total=	123

#	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.