SABANCI UNIVERSITY
FACULTY OF ENGINEERING AND NATURAL SCIENCES
MATERIALS SCIENCE AND ENGINEERING PROGRAMME
MAT 308 PHASE EQUILIBRIA (2 (Th)+1(F))

Instructor	Asst. Res. Prof. Yılmaz Şimşek	**T.A.**	Yasin Öztürk
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Office Hours	Tuesday 11:30-12:30	**Office hours**	Flexible **-** can be set up by e-mail

COURSE SCHEDULE

Type	Time	Where
Hybrid: Class & Online	Tuesday, 9:40 am – 11:30 am	Fac. Of Arts and Social Asc. **Room:** G049
Hybrid: Class & Online	Wednesday, 4:40 pm – 5: 30 pm	Fac. Of Engin. And Nat. Sci. **Room:** L029

ASSESSMENT and EVALUATION

Homework Quiz	10%	**Students are expected to/responsible for**
Midterm exam	25%	▪ Attend to all classes regularly, participate in discussions ▪ Prepare themselves for the next lecture from their text book
Term Project	25%	▪ The material covered in class
Final Exam	40%	▪ Check their emails, SU-Course and Banner-web daily for any announcements

COURSE DESCRIPTION

Phase Equilibria introduces students to the thermodynamic principles and their applications in the materials engineering e.g. the state of thermodynamic systems, phase equilibrium of the system and phase transition, stability of the phases and phase boundaries with respect to temperature, pressure, and composition. The course focuses on basis of thermodynamic and phase equilibria with a specific outline one component system phase diagrams; two component system phase diagrams: binary eutectic, intermediate compounds, solid solution, liquid immiscibility; determination of phase diagrams: experimental methods, thermodynamic estimations and calculations; ternary systems: method of determining composition, isoplethal studies in ternary systems, binary and ternary intermediate compounds, solid solutions; quaternary systems.

COURSE AIM

The aim of the course is to provide a sound foundation in the basic facts and concepts of phase equilibria for materials engineers.

RECOMMENDED PREREQUISITE COURSES

ENS 202 Thermodynamics
ENS 205 Introduction to Materials Science

SUGGESTED BOOKS

Bergeron C.G. & Risbud S. H. (1984). *Introduction to Phase Equilibria in Ceramics,* The American Ceramic Society, Inc.
Berard M.F. & Wilder D.R. (1990). *Fundamentals of Phase Equilibria in Ceramic Systems,* R.A.N. Publishers.

LEARNING OUTCOMES AND SUB-ACCOMPLISHMENT

1. The importance of phase diagrams in materials science and engineering will be able to be defined.

2. The main definitions and terms of phase diagram will be able to be explained.
a) The terms of system, phase, equilibrium, components, degrees of freedom, and phase rule are defined.
b) These terms are applied in materials science and engineering field.

3. In which conditions materials are stable will be interpreted in the unary systems by using pressure and temperature diagram.
a) Pressure and temperature diagrams are defined in unary systems.
b) The terms of phase diagrams are applied in the unary systems which are used in materials science and engineering field.
c) These unary systems are compared and interpreted each others.

4. Binary systems will be able to be composed by using unary systems.
a) Binary systems are designed by using unary systems.
b) These systems are drawn and interpreted

5. Problems will be able solved in binary systems by using composition and temperature diagram.
a) Composition and temperature diagrams are defined in binary systems.
b) The formations of congruently-incongruently melted intermediate compounds and solid solutions are defined in binary systems.
c) Different reaction types are defined in binary systems.
d) Calculations on cooling and heating are done in binary systems.
e) Calculations of phase equilibrium diagram are done in binary systems.
f) Composition and temperature diagrams are composed by using ΔG-T graphics.
g) The terms of phase diagrams are applied in the binary systems which are used in materials science and engineering field.
h) These binary systems are compared and interpreted each others.

6. Ternary systems will be able to be composed by using binary systems.
a) Ternary systems are designed by using binary systems
b) These systems are drawn and interpreted.

7. Problems will be able to be solved in ternary systems by using composition diagram.
a) Composition and temperature diagrams are defined in ternary systems.
b) The formations of congruently-incongruently melted intermediate compounds and solid solutions are defined in ternary systems.
c) Different reaction types are defined in ternary systems.
d) Isothermal sections are drawn in ternary systems.
e) Calculations on cooling and heating are done in ternary systems.
f) Calculations of phase equilibrium diagram are done in ternary systems.
g) Ternary systems are composed from binary systems.
h) The terms of phase diagrams are applied in the ternary systems which are used in materials science and engineering field.
i) These ternary systems are compared and interpreted each others.

8. Quaternary and six components systems will be introduced using composition diagrams.

COURSE OUTLINE

***Week 1* Introduction:**

The importance of phase diagram on materials science and engineering
Examine the relationship between thermodynamics and phase diagrams
The main definitions and terms of phase diagrams:
a) System, b) Phase, c) Equilibrium, d) Component, e) Degrees of freedom, f) Phase rule

***Week 2* Unary systems:**

a) Phase rule for uniary systems
b) Pressure-temperature diagrams in unary systems
c) Some, important unary systems used in materials science and engineering field

***Week 3* Binary systems:**

a) Introduction to binary systems
b) Types of binary alloy systems – examples
c) Binary isomorphous systems
d) Lever rule and isoplethal studies

***Week 4* Binary isomorphous systems:**
a) Heating-cooling calculations
b) Thermodynamic calculations - ΔG-X-T diagrams
c) Introduction to eutectic systems

***Week 5* Binary eutectic systems:**

a) Phase calculations,
b) Heating/cooling curves / isoplethal studies
c) Equilibrium/non-equilibrium microstructures
d) Thermodynamic calculations - ΔG-X diagrams
e) Other eutectic-like systems

***Week 6* Binary peritectic systems:**

a) Phase calculations,
b) Isoplethal studies
c) Other peritectic-like systems

***Weeks 7*: Hypothetical Binary System**

a) Hypothetical Binary System
b) Phase Analysis Diagrams
c) Recitation – preparation for the Midterm
d) Term project assignment (will be prepared individually or in groups of two students)

***Weeks 8* Midterm exam**

a) Recitation – preparation for the Midterm
b) Midterm Exam

***Weeks 9* Ternary systems:**

a) Introduction to ternary systems
b) Space model of ternary system
c) Composing ternary systems by using binary systems
d) Determination of composition in ternary systems
e) Tie lines and Tie triangles in ternary phase diagram
f) Ternary isomorphous system

***Week 10* Ternary systems:**

a) lsoplethal studies in ternary systems
b) Quantitive calculation on the ternary systems using lever rule
c) Alkemade lines and Alkemade theorem

***Weeks 11* Ternary systems:**

a) Construction of isothermal sections
b) Construction of vertical sections (isopleth)
c) Exercises for Isoplethal Study
d) Ternary system with Solid Solution
e) Examples of the Ternary System

***Week 12* Ternary systems:** *(End of the week→ Deadline for submission of the midterm project)*

a) Q/A sections for the previous sections
b) Discussion about formats for midterm project and exams
c) Introduction to Quaternary System

***Week 13* Term projects:**

Oral presentations of midterm projects

***Week 14* Final Exam:**