MSE-204 Thermodynamics for Materials Science

L0. Introduction

Discussion on What is Thermodynamics | Course Details

Vaso Tileli | MXD 237

WHY DO WE STUDY THERMODYNAMICS?

1. It applies…

2. It is capable…

3. It is well established…

4. ...

What Determines How Matter Behaves?

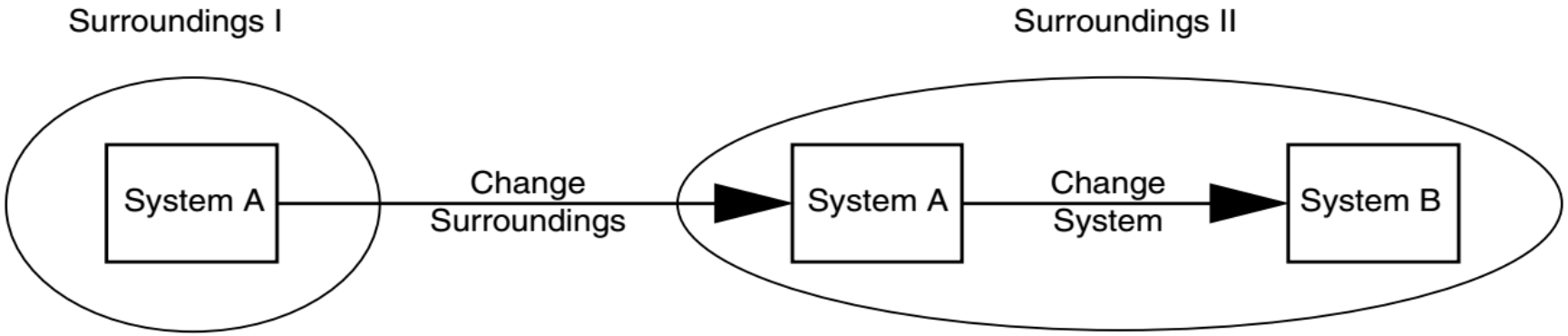
There are three approaches

1.

2.

3.

THE GENERIC QUESTION ADDRESSED BY THERMODYNAMICS

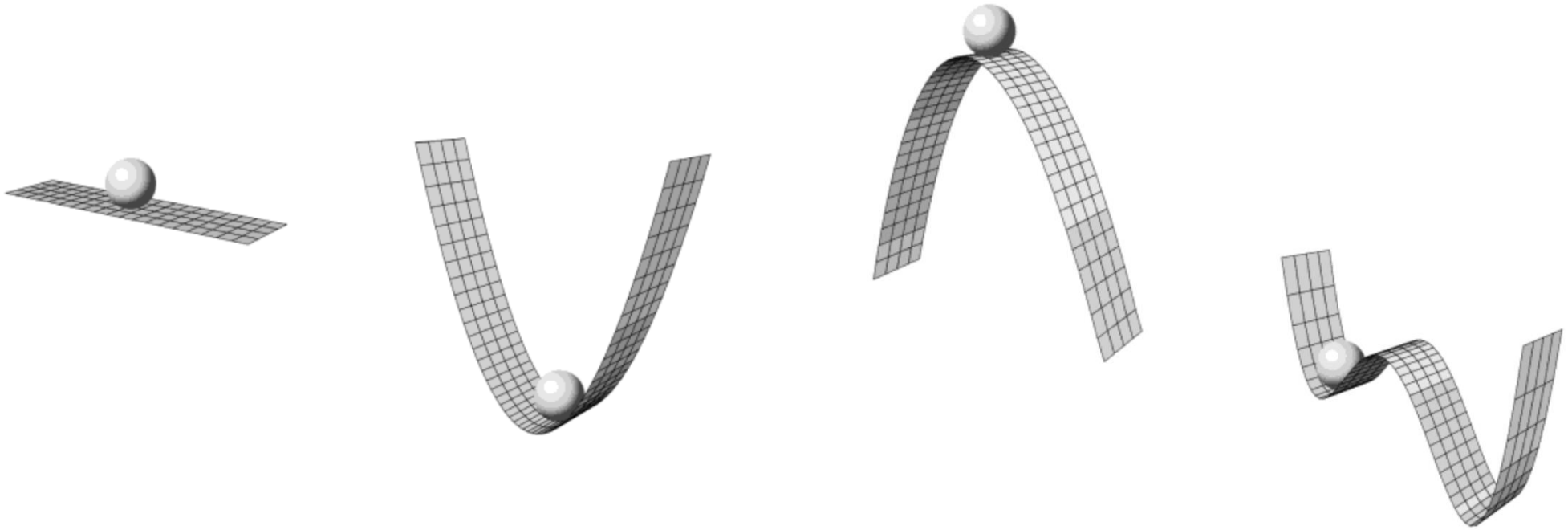


The design of materials has to do with how the properties of material will change with response to the environment. These responses will determine how we can synthesize of fabricate the materials and how the devices will operate in a given application.

THERMODYNAMICS IS LIMITED TO SYSTEMS IN EQUILIBRIUM

Thermodynamics is limited to the description of systems that are in equilibrium with their surroundings. It provides the basis for predicting what the properties of an equilibrated system will be as a function of the content of the system and the characteristics of its surroundings.

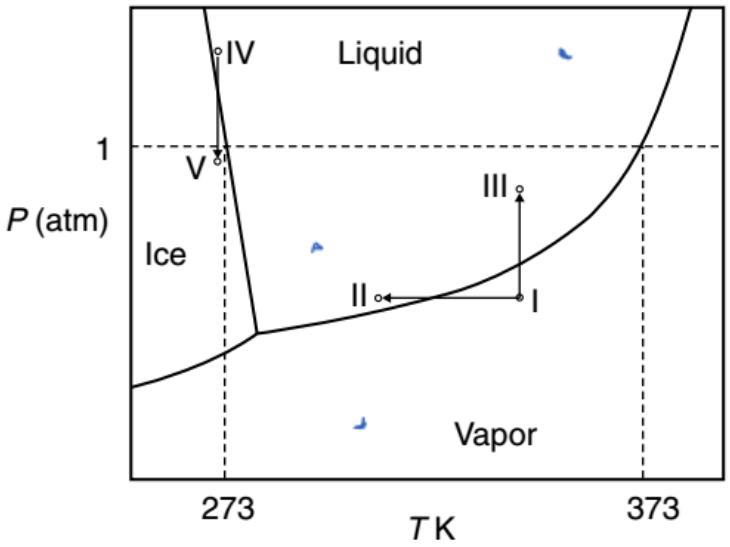
Analogy to potential energy: a ball rolling on hills and valleys:



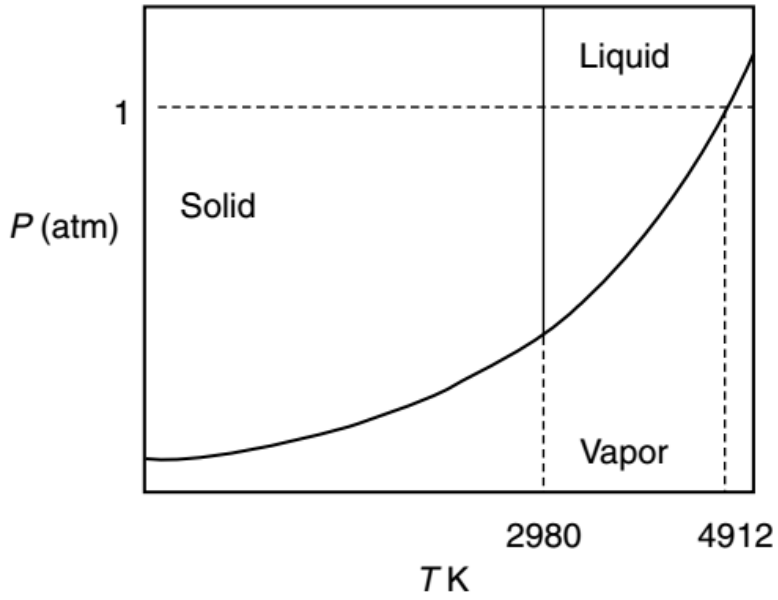
Thermodynamics is the Basis for Equilibrium Maps

The real utility of thermodynamics lies in its ability to predict whole patterns of behavior for a range of systems in a range of surroundings. These patterns are conveniently presented in the form of maps of equilibrium states. The generation of these maps is the main topic of this course.

Water



Molybdenum



THERMODYNAMICS IS THE BASIS FOR EQUILIBRIUM MAPS

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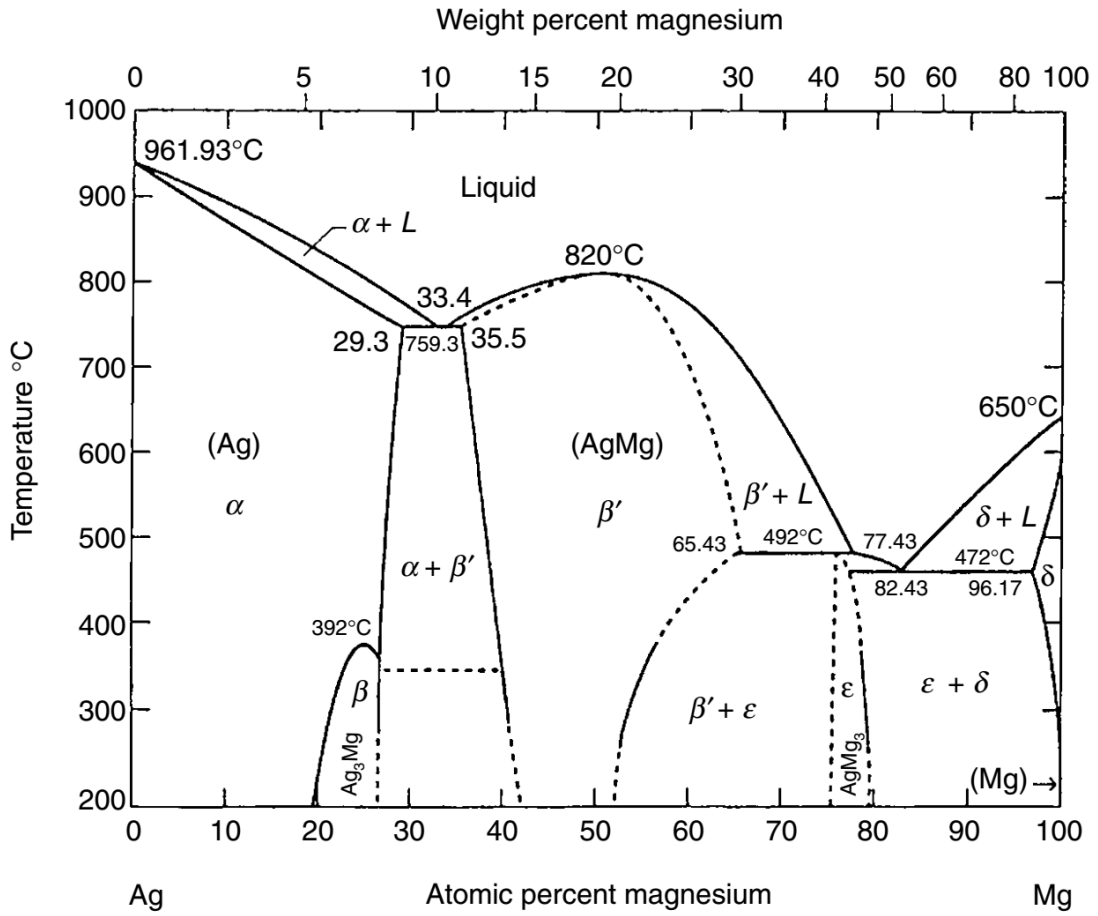
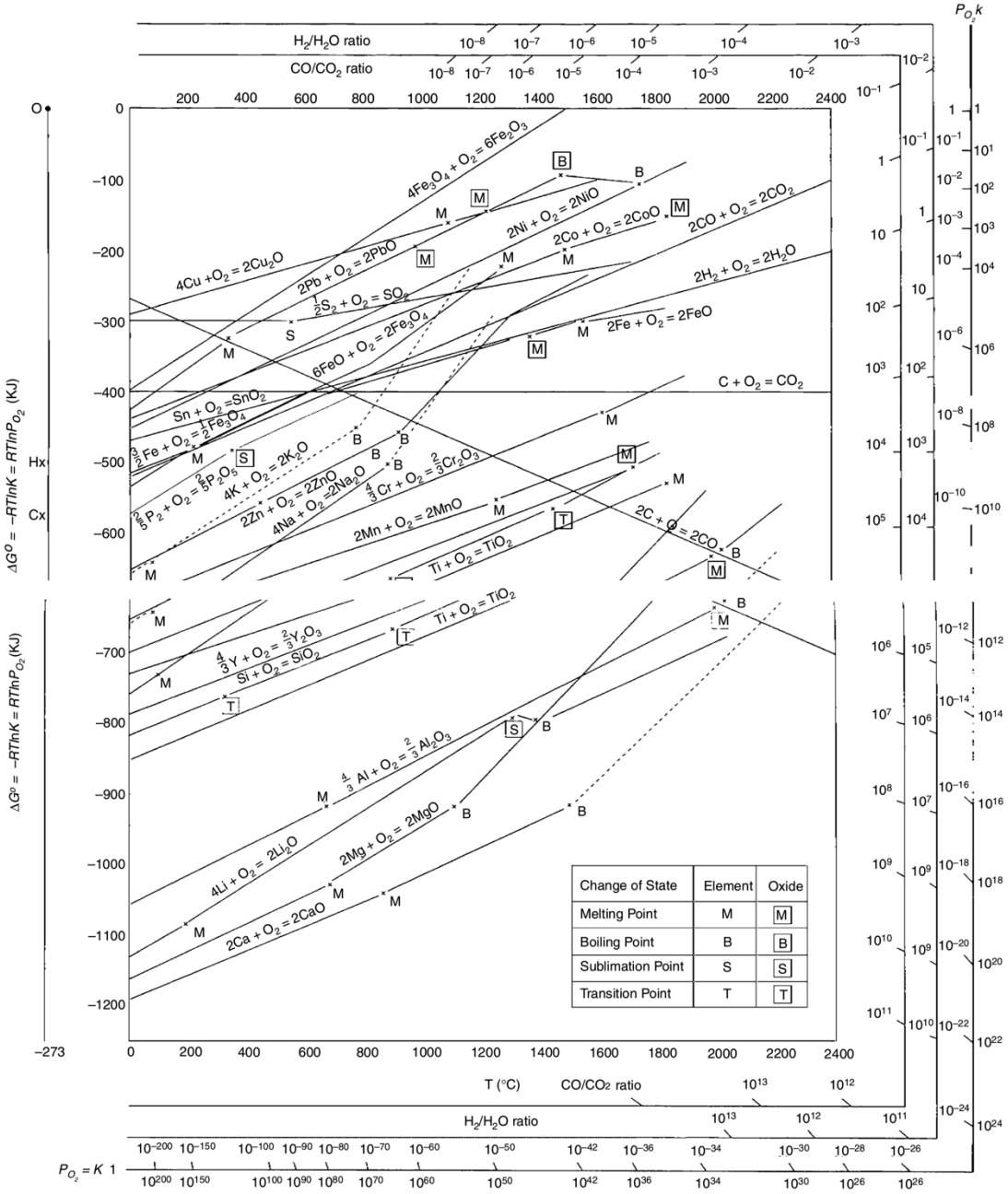


Silver magnesium phase diagram at 1atm, each point represents the equilibrium structure of a particular Ag-Mg composition at a particular temperature

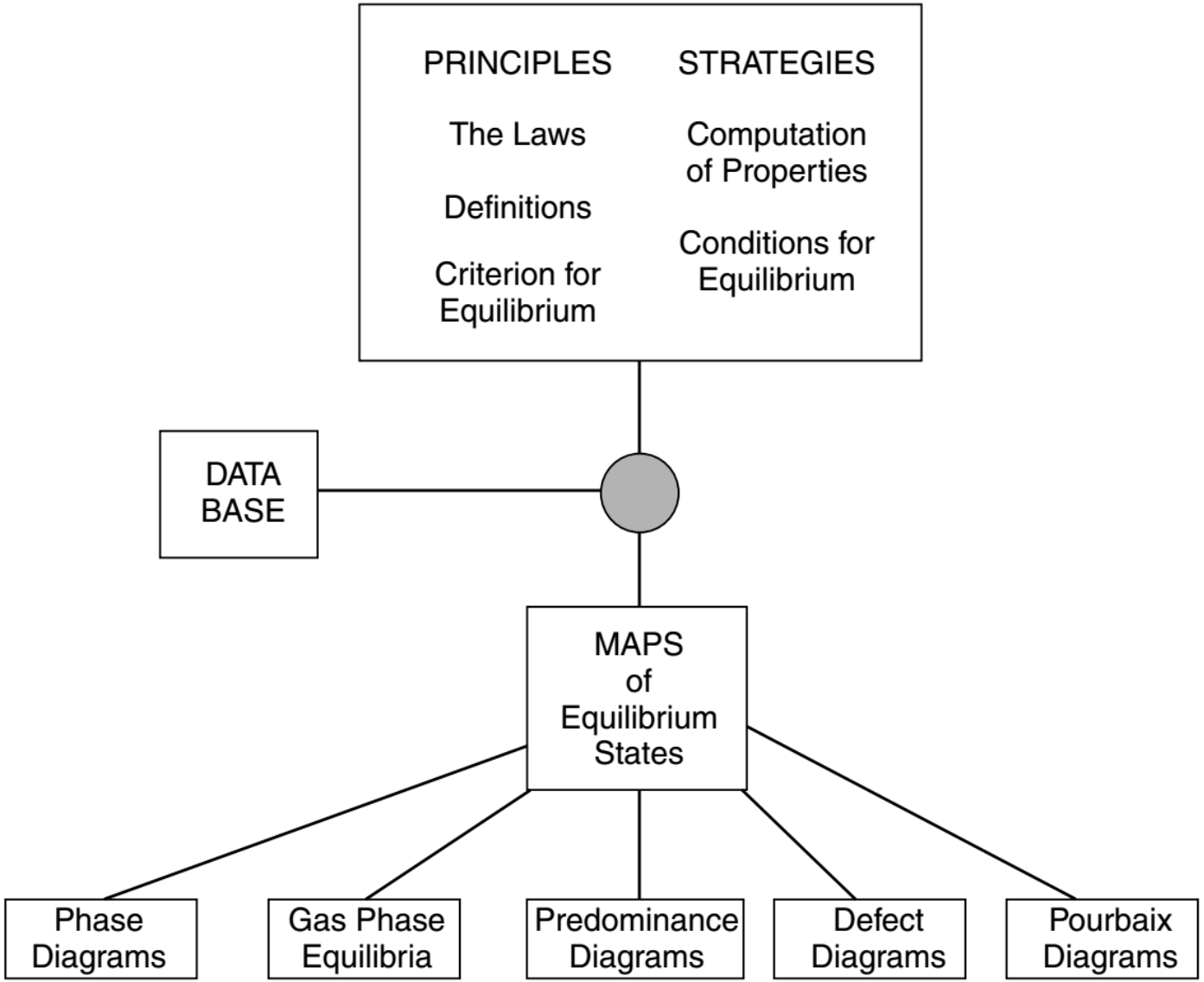
Thermodynamics is the Basis for Equilibrium Maps



Used to:

- Determine the relative ease of reducing a given metallic oxide to metal;
- Determine the partial pressure of oxygen that is in equilibrium with a metal oxide at a given temperature; and

THE THERMODYNAMIC BASIS FOR EQUILIBRIUM MAPS



ESSENTIAL INFORMATION ABOUT THIS COURSE

MSE 204: Thermodynamics for Materials Science (3 credits) | Course Details

Instructor	Vaso Tileli
Teaching Assistants	Guoyuan Liu, Simone Sigagna, and Claire Paetsch
Time/Place	Mondays 10.15-12.00 – two hour lecture
	Mondays 12.15-13.00 – one hour exercise session
Pre-requisites	Introduction to Materials Science and Engineering

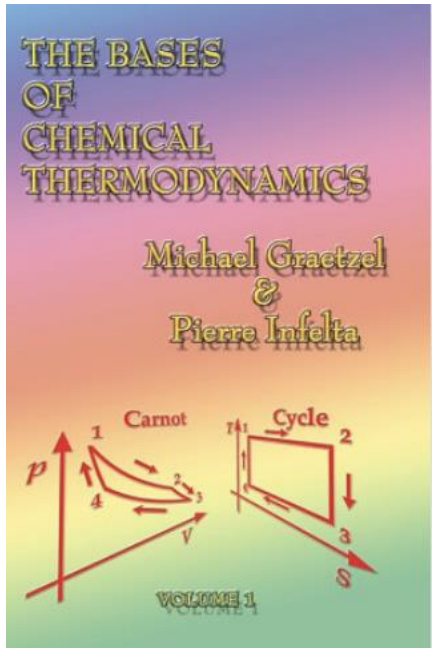
Textbook

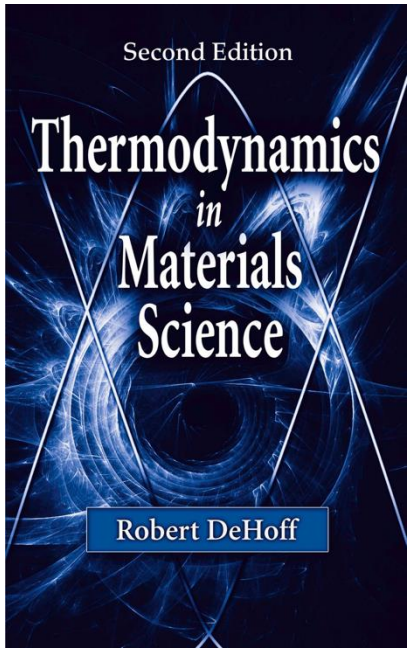
Lecture slides (on moodle)

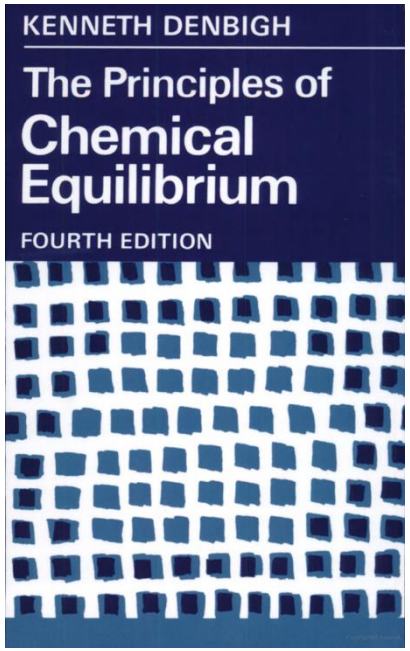
ESSENTIAL INFORMATION ABOUT THIS COURSE

Reference Books

- The Bases of Chemical Thermodynamics, M. Graetzel & P. Infelta, Universal Publishers, 2000. | (two volumes in English, one volume in French)
- Thermodynamics for Materials Science, R. DeHoff, CRC Press, 2006.
- The Principles of Chemical Equilibrium, K. Denbigh, Cambridge University Press, 1981







Essential Information about This Course

08.09	Week 1	L0. Introduction | L1. The Laws
15.09	Week 2	L1. Thermodynamic Laws & Their Meaning (Cont'd)
22.09	Week 3	No Class
29.09	Week 4	L2. Auxiliary Functions & Their Meaning
06.10	Week 5	L3. Molar Quantities
13.10	Week 6	L4. Partial Molar Quantities (Cont'd)
20.10	Week 7	No Class
27.10	Week 8	L5. Thermodynamics of Gases
03.11	Week 9	L6. Introduction to Phases
10.11	Week 10	L7. Single Component Phase Diagrams
17.11	Week 11	L8. Multicomponent Phase Diagrams
24.11	Week 12	L9. Metastability of Phases
01.12	Week 13	L10. Reacting Systems
08.12	Week 14	L11. Summary Revision
15.12	Week 15	FINAL EXAM

Every Monday morning: 2-hour lecture (90 min in total) followed by 1-hour exercise session (3Tas +1)

Monday afternoon (or shortly after) the annotated slides will be uploaded, along with the exercise sheet for the next week and the solutions of the exercises done the same day in class)

Final Exam (100% of the total grade): The final exam will be on Week 14. Books/notes open, electronic devices off.