MEMS 1059: Phase Equilibria in Multicomponent Materials
Fall 2022

Credits and contact hours (lecture/lab): 3 Credits, 3 Contact Hours (2 lecture, 1 recitation)

Designated as 'Required' or 'Elective' Course: Required

Course description: Thermodynamics of solutions with applications to materials systems; heterogeneous phase equilibria; relations between free energy and phase diagrams; electrochemistry; rate processes; thermodynamics of surfaces and interfaces.

Prerequisite and Co-requisite: (ENGR 0022 or MET 1162) and (ME 0051 or MEMS 0051 or MET 1110 or BIOENG 1210); LVL: Jr or Sr; PROG: SCUPI CE, IE and MSE

Textbook: D. R. Gaskell and D. Laughlin, Introduction to the Thermodynamics of Materials, 6th ed., Taylor & Francis, ISBN 9781315119038, 2017. https://doi.org/10.1201/9781315119038

Reference Textbooks: G.H. Meier, "Thermodynamics of Surfaces and Interfaces: Concepts in Inorganic Materials," Cambridge University Press, online ISBN 9781139047029, 2014. https://doi.org/10.1017/CBO9781139047029

N. Birks, G.H. Meier, and F. S. Pettit, "Introduction to the High Temperature Oxidation of Metals," Cambridge University Press, 2nd Edition, ISBN: 9780521480420, 2006.

Other required materials: None

Course Instructor: Charles Hua, charleshua2017@scupi.cn Office Location 3-322B
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Teaching Assistant: Florence Zhao 2019141520076@stu.scu.edu

Course Objectives: The course is designed to give juniors in MSE and Engineering Sciences an understanding of classical thermodynamics and its application to materials problems.

Course learning outcomes/expected performance criteria:

1. Thermodynamics of Solutions (70%)
2. Binary Phase Diagrams (70%) Ternary Phase Diagram (30%)
3. Free Energy Diagrams (70%)

4. Chemical Reaction Equilibria (70%)
5. Thermodynamics of Electrochemical cells (70%)
6. Thermodynamics of Surfaces and Interfaces (70%)

Course topics and time devoted to each topic:
Review of Basic Thermodynamics (2 weeks)
Thermodynamics of Solutions (3 weeks)
Phase Equilibria and Free Energy Diagrams (3 weeks)
Chemical Reactions Involving Gases (1 week)
Reactions Involving Solids and Gases - Thermochemical Diagrams (1 week)
Reactions Involving Solutions (1 week)
Electrochemistry (1 week)
Thermodynamics of surfaces (1 week)
Research in Progress: Phase Transition at Clad Interfaces (>2 weeks)

Class/laboratory schedule:
Monday 8:15-11:00am
Location: Teaching Building A103

Contribution of course to meeting the requirements of criterion 5:	Engineering Science:	3 Credits
	Engineering Design:	0 Credits
	College Level Mathematics:	0 Credits
	Basic Science:	0 Credits
	Realistic Constraints:	0 Credits

Materials Science & Engineering Program outcomes addressed:
This course is not used to evaluate program outcomes.

Prepared by: Charles Hua, Adapted from Prof. Gerald H. Meier, University of Pittsburgh

Date: July 26, 2019 **Revised on August 1, 2022**

Web Site

Pibb.scu.edu.cn

There you will find the course syllabus, lecture files, readings, studio and homework assignments, and other materials. Current announcements and assignments will be posted on the home page. All assignments will be uploaded through the Blackboard system. Please check the class page frequently.

Class Format

Phase Equilibria in Multicomponent Materials is taught using a combined lecture/quiz format. The class begins with a session lecture to review material from the textbook (especially from ENGR0022, Material Structures and Properties), and introduce new concepts. In the second and third session, the lecturer may ask questions to as many students as possible and then continue with textbook.

It is imperative that you come to class prepared. This will generally involve reading one or more chapters of the textbook, viewing tutorial videos, thinking, engaging with fellow students, practice and performing preliminary calculations. This is a three credit hour class, which means you should expect to devote at least 6 hours of effort outside the scheduled class time every week.

Homework Assignments

Homework problems will be assigned every 2 weeks or so in the class and/or posted on Blackboard. These are to be solved and turned in by **Sunday**. You may work with other people on homework, but all write-ups must be individual efforts. Homework will be graded on a 0-100 point scale.

All work will be submitted electronically through the Blackboard system. Late homework will not be accepted.

Unless specifically requested, emailed homework will not be accepted.

Please adhere to these homework guidelines:

- Your assignment must be typeset using Word and submitted electronically through Blackboard. Handwritten assignments will not be accepted.
- Put your name, ID number (last four digits), and class section at the top of the first page.
- List the names of other people you've worked with on the assignment.
- All work must be shown for each solution to receive full credit. Present your solution in a logical fashion, showing and explaining all steps in detail.
- A significant amount of the homework points is associated with obtaining the correct answer. This includes getting the correct quantity, number of significant digits, sign, and unit.

All of the homework scores will be used in your grade computation. Unless otherwise indicated, you can work with your fellow classmates in the class, but you must submit a distinct and independent write-up to receive credit.

If you're sick, or have a compelling emergency that prevents you from turning in the homework on time, email Prof. Charles Hua, charleshua2017@scupi.cn. When emailing the instructor or TA, include "MSE1059" in the subject field of your message. Use your university email account (ID_number@stu.scu.edu.cn); mail from other accounts might be stopped by the SCU spam filter.

If you believe an error has been made in the grading of an assignment, bring it to the attention of your TA within ONE WEEK of its return.

Exams and Grading

The will be a mid-term exams and one final exam.

The test and exam are CLOSED BOOK, CLOSED NOTES, CLOSED COMPUTER. You may bring one A4 page of notes (single side) by YOUR OWN handwriting. You will also find a calculator and a straightedge helpful.

Your grade will be based on the homework (25%), class participation (input-output QA 15%), mid-term exam (30%), and final examination (30%). If your homework is submitted late, you lose 10% of the credits per day past due, and have zero credit one week past due. You should participate actively in the class in order to grasp the important concepts. If you are found using cellphone or playing video games in the classroom during the lecture hours, you will lose the participation credits. For your information, the average grade at University of Pittsburgh is 55 points in the academic year 2016-17.

Office Hours

If you don't understand something, and talking to your classmates doesn't help, then you should be seeking help from the instructor or teaching assistant.

Office hours are times we have specifically set aside to be available to students. During office hours, you can come to our office; you don't need an appointment. We are also available at other times; please email to schedule a time.

Current office hours will be Monday afternoon, 1-5pm, Zone 3 -322B. Online flexible time.