City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2023/24

Part I Course Overview

Course Title:	**Kinetic and Thermodynamic Properties of Materials**
Course Code:	**MSE8021**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**R8**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: ***(Course Code and Title)***	**Nil**

Part II Course Details

1. Abstract

The course aims to provide graduate students a solid foundation of thermodynamics and kinetics of materials. It emphasizes fundamental theory and quantitative analysis. The thermodynamics section includes classical laws of thermodynamics, their statistical perspectives, single and multi-component systems, thermodynamics of phase diagram, multiphase and reacting systems, and thermodynamic of defects. The kinetics section covers motion of point, line, and interface defects. The course will also introduce general features of phase transformation, nucleation and growth theory, and martensitic transformation. Upon successful completion of the course, students will be equipped with sufficient knowledge to analyse a wide range of processes during changes in material compositions, phases and microstructures.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Analyze and calculate thermodynamic material properties and process variables using the laws of thermodynamics.			√	
2.	Understand and analyze the equilibrium criteria and equilibrium conditions of systems with different constraints.			√	
3.	Understand the basics of statistical mechanics and describe the relations between microscopic and macroscopic thermodynamic properties.		√	√	
4.	Explain and analyze thermodynamic properties in single and multicomponent materials, and phase diagrams based on the equilibrium criteria.		√	√	
5.	Understand and analyze thermodynamics and kinetics of point, line and interface defects.			√	√
6.	Understand and analyze thermodynamic and kinetic aspects of phase transformations.			√	√
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5	6	
Lecture	Explain and discuss the key concepts about the laws of thermodynamic, thermodynamic relationships, single component and multi-component phase equilibria as well as statistical thermodynamics theory, phase diagram, thermodynamics and kinetics of defects, phase transformation.	√	√	√	√	√	√	2
Tutorial	Explain and analyze solutions to practical problems.	√	√	√	√	√	√	1

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5	6		
Continuous Assessment: 40 %								
Midterm	√	√	√				20 %	There will be one midterm test
Assignment	√	√	√	√	√	√	20 %	Take-home assignments
Examination: (duration: 2 hrs)	√	√	√	√	√	√	60 %	
** The weightings should add up to 100%.*							100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Midterm	Able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic principles	High	Moderate	Basic	Not even reaching the marginal level
2. Assignment	Able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic principles	High	Moderate	Basic	Not even reaching the marginal level
3. Examination	Able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic principles	High	Moderate	Basic	Not even reaching the marginal level

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Midterm	Able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic principles	High	Significant	Moderate	Basic	Not even reaching the marginal level
2. Assignment	Able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic principles	High	Significant	Moderate	Basic	Not even reaching the marginal level
3. Examination	Able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic principles	High	Significant	Moderate	Basic	Not even reaching the marginal level

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

- The structure and laws of thermodynamics
- Thermodynamic variables and relationships
- Thermodynamic equilibrium criteria and equilibrium conditions
- Basics of statistical mechanics
- Single component systems
- Multicomponent system: solution and heterogeneous materials
- Thermodynamics of phase diagram, phase diagram
- Multicomponent, multiphase, reacting systems
- Driving force, equation and solution of diffusion processes
- Motion of dislocation, surface and interface
- Homogeneous and heterogeneous nucleation and growth
- Diffusionless phase transformation, massive transformation and martensitic transformation

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Lecture slides
2.	Tutorial problems and solutions

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Robert T DeHoff, "Thermodynamics in Materials Science", New York, McGraw-Hill, 1993.
2	Kinetics of Materials, RW Balluffi, SM Allen, WC Carter, Wiley & Sons, New Jersey.
3.	Phase Transformations in Metals and Alloys, DA Potter, KE Easterling, Chapman and Hall.
4.	The Theory of Transformations in Metals and Alloys, JW Christian, Pergamon Press, Oxford.
5.	DV Ragone, Thermodynamics of Materials, Vols. 1 and 2, John Wiley and Sons, NY, 1995.