City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2024/25

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 (i) derive quantitative relations among different material properties and variables, and (ii) 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.	Analyse and calculate thermodynamic material properties and process variables using the laws of thermodynamics and equilibrium criteria.			√	
2.	Apply basic statistical mechanics and describe relations between microscopic and macroscopic thermodynamic properties.		√	√	
3.	Derive and calculate thermodynamic properties in single and multicomponent materials using statistical mechanics, macroscopic properties and phase diagrams.		√	√	
4.	Describe and analyse thermodynamics and kinetics of point, line and interface defects.			√	√
5.	Describe and analyse thermodynamics, kinetics and physical mechanisms 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 real-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. Learning and Teaching Activities (LTAs)

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

LTA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lecture	Students will engage in formal lectures to acquire key concepts and theories about the laws of thermodynamic, thermodynamic relationships, single component and multi-component phase equilibria as well as statistical thermodynamics, phase diagram, thermodynamics and kinetics of defects and phase transformation.	√	√	√	√	√	2
Tutorial	Students will enhance their mastery of theory and participate in practical problem-solving processes.	√	√	√	√	√	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		
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 before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Midterm	Be able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic thermodynamics and statistical mechanics principles.	High	Significant	Moderate	Basic	Not even reaching the marginal level
2. Assignment	Be able to derive thermodynamic property relations and calculate material thermodynamic properties, and apply theory to solve practical problems.	High	Significant	Moderate	Basic	Not even reaching the marginal level
3. Examination	Be able to derive thermodynamic property relations and calculate quantitative material properties, and demonstrate the understanding of thermodynamic and kinetic theories and apply them in practical problems.	High	Significant	Moderate	Basic	Not even reaching the marginal level

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Midterm	Be able to derive thermodynamic property relations and solve quantitative problems, and demonstrate the understanding of basic thermodynamics and statistical mechanics principles.	High	Moderate	Basic	Not even reaching the marginal level
2. Assignment	Be able to derive thermodynamic property relations and calculate material thermodynamic properties, and apply theory to solve practical problems.	High	Moderate	Basic	Not even reaching the marginal level
3. Examination	Be able to derive thermodynamic property relations and calculate quantitative material properties, and demonstrate the understanding of thermodynamic and kinetic theories and apply them in practical problems.	High	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 notes
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.