City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2021/22

Part I   Course Overview

Course Title:	**Thermodynamics of Materials**
Course Code:	**MSE8011**
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 of materials for them to embark on research in Materials Science and Engineering. The course will provide a comprehensive treatment of the thermodynamics of materials and their applications, including the laws of thermodynamics, state functions, statistical mechanics, single and multi-component systems, thermodynamics of phase diagram, multiphase and reacting systems and thermodynamic of interfaces and defects. Upon successful completion of the course, students are expected to be equipped with sufficient knowledge to analyse thermodynamic properties and processes, as well as to describe and to determine the equilibrium states/properties of materials for advanced studies. The course also weaves in selected elements of statistical thermodynamics related to macroscopic equilibrium phenomena.

2.   Course Intended Learning Outcomes (CILOs)

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 heterogeneous phase diagrams based on the equilibrium criteria.		√	√	
5.	Describe and analyze defect thermodynamics and their influences on material properties.			√	
		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)

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

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting*	Remarks
	1	2	3	4	5		
Continuous Assessment: 40 %							
Midterm	√	√	√	√	√	30 %	There will be one midterm test
Assignment	√	√	√	√	√	10 %	Take-home or in-class assignments
Examination: (duration: 2 hrs)	√	√	√	√	√	60 %	
						100%	

5. Assessment Rubrics

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Test	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

- Capillary effects

- Defects in Crystals

- Thermodynamics under external fields

- Electrochemistry

2.   **Reading List**
2.1 **Compulsory Readings**

1.	Lecture slides
2.	Tutorial problems and solutions

2.2 **Additional Readings**

1.	Robert T DeHoff, "Thermodynamics in Materials Science", New York, McGraw-Hill, 1993.
2.	Introduction to the Thermodynamics of Materials, David R Gaskell, Fifth Edition, Taylor & Francis, 2008
3.	Modern Thermodynamics: From Heat Engines to Dissipative Structures, Dilip Kondepudi and Ilya Prigogine, Wiley, 2002
4.	Yunus A Çengel, Michael A Boles, "Thermodynamics – An Engineering Approach", 6th ed. in SI units, McGraw-Hill, 2008.
5.	D. V. Ragone, Thermodynamics of Materials, Vols. 1 and 2, John Wiley and Sons, NY, 1995.