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:	**Advanced Structural Materials**
Course Code:	**MSE6185**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**P6**
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

This course will be focused on providing comprehensive understanding of scientific concepts and principles used for advanced structural materials, with emphasis on the advanced metallic materials. It will include the microstructures of solids, processing and fabrication, compositional adjustment, metallurgical principles, and development of structure-property correlation. The goal of this course is to achieve that senior and graduate students are able to (1) understand the basic concepts of the advanced structural materials; (2) select and design different structural materials with superior properties for various engineering fields; (3) identify and solve some critical issues in manufacturing and practical applications of these materials

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.	**Describe** the development for most common and advanced structural materials	15%	√		
2.	**Describe and explain** the typical properties and applications of these materials	15%		√	
3.	**Identify** the inner relationship between material properties, processing, and microstructures	25%			√
4.	**Explain** the scientific and metallurgical principles used for alloy design and microstructural control	25%		√	
5.	**Apply** the scientific and metallurgical principles to solve crucial problems in manufacturing and practical applications of these materials	20%		√	
		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	
Lectures	Students will engage with fundamental theories and concepts.	√	√	√	√	√	2 hrs/week
Tutorials	Students will engage in group discussions to improve the understanding of lecture contents.	√	√	√	√	√	1 hrs/week
Peer discussions	Students will engage in structured discussions on the research articles published in top journals to improve the problem-solving abilities.			√	√	√	2 hrs/week

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: 70%							
Quiz	√	√	√	√	√	20%	
Assignment	√	√	√	√	√	20%	
Mid-term test	√	√	√			20%	
Group presentation			√			10%	
Examination: 30% (duration: 2 hours)							
						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. Quiz	Ability to understand the fundamental theories and concepts	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignment	Capability for self-directed learning to strengthen the understanding of some critical scientific issues	High	Significant	Moderate	Basic	Not even reaching marginal levels
3.Group presentation	Ability to understand and master the art of creative thinking towards problem solving	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Mid-term test	Ability to identify and explain the inner relationship between material properties and microstructures	High	Significant	Moderate	Basic	Not even reaching marginal levels
5. Final examination	Ability to comprehensively master the scientific principles and use them to solve some theoretical and application problems	High	Significant	Moderate	Basic	Not even reaching marginal levels

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. Quiz	Ability to understand the fundamental theories and concepts	High	Moderate	Basic	Not even reaching marginal levels
2. Assignment	Capability for self-directed learning to strengthen the understanding of some critical scientific issues	High	Moderate	Basic	Not even reaching marginal levels
3.Group presentation	Ability to understand and master the art of creative thinking towards problem solving	High	Moderate	Basic	Not even reaching marginal levels
4. Mid-term test	Ability to identify and explain the inner relationship between material properties and microstructures	High	Moderate	Basic	Not even reaching marginal levels
5. Final examination	Ability to comprehensively master the scientific principles and use them to solve some theoretical and application problems	High	Moderate	Basic	Not even reaching marginal levels

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

1. Keyword Syllabus

(An indication of the key topics of the course.)

(1). Overview of advanced structural materials
(2). States and microstructures of matters:
  (a). Atomic structures
  (b). Phase diagram and diffusion
  (c). Crystal structure and defect
  (d). Strengthening and toughening mechanisms
  (e). Advanced manufacturing
(3). Typical mechanical properties (elastic, strength, ductility, fracture toughness…)
(4). Non-mechanical Properties (grain growth, corrosive, oxidation…)
(5). Advanced structural materials:
  (a). Steels
  (b). Superalloys and intermetallics
  (c). High-entropy alloys
  (d). Light-weight alloys
  (e). Bulk metallic glasses (BMGs)
  (f). Structural-gradient alloys

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. Soboyejo, Winston O., and T. S. Srivatsan, eds. Advanced structural materials: properties, design optimization, and applications. CRC press, 2006.
2. Physical Metallurgy Principles, RE Reed-Hill and R Abbaschian, PWS-KENT Pub, Boston.

2.2 Additional Readings

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

1. Ferdinand P. Beer, E. Russell Johnston, John T. DeWolf and David F. Mazurek, Mechanics of Materials, 6th edition, McGraw-Hill, New York, 2012, ISBN: 978-0-07-131439-8.
2. Priester L. Grain boundaries: from theory to engineering[M]. Springer Science & Business Media, 2012.
3. Smith, William F. Structure and properties of engineering alloys. McGraw-Hill, 1993.
4. The superalloys: fundamentals and applications by Rogers C. Reed, Cambridge University Press, 2006.
5. Recent papers on nanostructured steels and intermetallic compounds by Profs. CT Liu, MW Chen, and Dr. T. Yang, et al.
6. Recent papers on structural-gradient metallic materials and SMAT materials by Prof. Jian Lu