City University of Hong Kong

Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2018 / 19

Part I Course Overview

Course Title:	**Kinetic Processes in Engineering Materials**
Course Code:	**MSE3109**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**B3**
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**MSE3190 Thermodynamics of Materials**
Precursors: *(Course Code and Title)*	**MSE2102 Introduction to Materials Engineering** **MSE3169 Materials Testing Techniques**
Equivalent Courses: *(Course Code and Title)*	**AP3109 Kinetic Processes in Engineering Materials**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

The course aims at covering the basic principles and processes pertinent to the kinetic aspects of structural changes in engineering materials. The development of microstructures, and hence the properties, in materials as a result of thermo-mechanical treatments will be highlighted. Upon successful completion of the course, students are expected to be equipped with scientific and engineering knowledge to perform qualitative and quantitative analyses of transformation kinetics of simple structural changes. They will also be able to design and apply simple thermo-mechanical treatment routes to conventional engineering alloys to achieve desirable properties.

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 quantitatively the diffusion processes in solids and the migration of interfaces.		√	√	
2.	Describe the nucleation and growth processes of phase transformation as well as spinodal decomposition.			√	√
3.	Analyze quantitatively phase transformation kinetics using the Johnson-Mehl Equation.		√		
4.	Relate the nucleation and growth processes to the heat treatments of steel and aluminium alloys.		√	√	√
5.	Explain the effects of annealing processing on cold-worked metals and the mechanisms involved.			√	√
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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		
Large Class Activities		√	√	√	√	√		2 hrs/week
Lab Work				√	√			0.5 hr/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: 40%								
Mid-term test	√	√		√	√		30%	
Lab reports			√	√			10%	
Examination^: 60% (duration: 2 hours)								
** The weightings should add up to 100%.*							100%	

^ For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

5. Assessment Rubrics

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

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Ability to describe and explain the scientific principles and to solve physics and engineering problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Lab report	Ability to explain the methodology and to analyse the data	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Mid-term test	Ability to explain scientific principles and to solve related problems	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Assignment	Ability to sum up, to assess, and to comment on the work of their peers	High	Significant	Moderate	Basic	Not even reaching marginal levels

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

1. Keyword Syllabus

- Surface/interface properties and phenomena (2 hours)
  Surface energy of solids, grain boundaries, interphase interfaces, impurity segregation at interface.
- Diffusion in solids (4 hours)
  Fick's laws, interdiffusion, high diffusivity paths.
- Nucleation and growth of phase transformation (4 hours)
  Nucleation and growth. Gibbs-Thompson effect. Precipitation coarsening.
- Spinodal decomposition (1 hours)
  Miscibility gap and spinodal curve, phase separation kinetics, microstructure resulting from spinodal decomposition.
- Transformation kinetics (1 hours)
  Arrhenius equation, Johnson-Mehl equation.
- Heat-treatment of carbon steel (5 hours)
  Fe-C system, eutectoid transformation, bainitic transformation, martensitic tranformation, hardening and tempering.
- Precipitation hardening of aluminium alloys (5 hours)
  GP-zones, Formation of intermediate phases, Oswald ripening.
- Recrystallization and annealing processing (4 hours)
  Recovery, recrystallization and grain growth, properties changes arise from annealing, engineering laws of recrystallization.

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.)

Nil

2.2 Additional Readings

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

1.	"Phase Transformations in Metals and Alloys", D A Porter and K E Easterling, 2nd ed., Chapman and Hall, 1992.
2.	"Physical Metallurgy Principles", R E Reed-Hill, R Abbaschian, 3rd ed., PWS-Kent, 1992.
3.	"Stability of Microstructure in Metallic Systems", J W Martin, R D Doherty and B Cantor, 2nd ed., Cambridge University Press, 1997.
4.	"Thermodynamics of Materials", David V Ragone, Wiley, 1995.