City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2022/23

Part I Course Overview

Course Title:	**Mechanics of Materials**
Course Code:	**MSE8018**
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

This course aims to provide graduate students a solid foundation of mechanics of materials with special emphases on materials aspects. Vector and tensor notations will first be introduced and used throughout the course. The kinematics and kinetics of deformation will be rigorously presented, followed by a thorough treatment on linear elasticity and related principles. Green's function for elasticity will be discussed for both isotropic and anisotropic materials. Material plasticity and fracture will be briefly covered. Special topics on point defects, dislocations, grain boundaries, precipitates, inclusions will be presented. Related strengthening mechanisms in alloys will also be discussed. Upon completion of the course, students are expected to have an in-depth understanding of mechanics of materials and be able to perform quantitative analysis in their research.

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.	Understand and use vector and tensor notations	10%	√	√	
2.	Understand and analyze deformation using linear elasticity	25%		√	
3	Understand and analyze material plastic deformation and fracture processes	25%	√	√	√
4.	Understand and analyze defect properties and their interactions	25%	√	√	√
5.	Understand and analyze strengthening mechanisms in materials	15%		√	
		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.

3. Teaching and Learning Activities (TLAs)

TLA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lecture	Presentation on key theory and principles, their derivations and applications	√	√	√	√	√	2 hrs/week
Tutorial and Group discussion	Discuss homework and additional problems	√	√	√	√		1 hrs/week

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting*	Remarks
	1	2	3	4	5		
Continuous Assessment: 50%							
Homework	√	√	√	√	√	25%	
Midterm	√	√	√	√		25%	
Examination: 50% (duration: 2 hrs)	√	√	√	√		50%	
						100%	

5. Assessment 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. Homework	Ability to carry out derivation of related theory, perform quantitative analysis and apply theory and models in applications	High	Moderate	Basic	Not even reaching the marginal leave
2. Midterm	Ability to carry out derivation of related theory, perform quantitative analysis and apply theory and models in applications	High	Moderate	Basic	Not even reaching the marginal leave
3. Examination	Capability to perform quantitative analysis on stress-strain behaviours, defect properties and their interactions, strengthening and fracture behaviours of materials	High	Moderate	Basic	Not even reaching the marginal leave

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. Homework	Ability to carry out derivation of related theory, perform quantitative analysis and apply theory and models in applications	High	Significant	Moderate	Basic	Not even reaching the marginal leave
2. Midterm	Ability to carry out derivation of related theory, perform quantitative analysis and apply theory and models in applications	High	Significant	Moderate	Basic	Not even reaching the marginal leave
3. Examination	Capability to perform quantitative analysis on stress-strain behaviours, defect properties and their interactions, strengthening and fracture behaviours of materials	High	Significant	Moderate	Basic	Not even reaching the marginal leave

Part III Other Information

1. Keyword Syllabus

Part I Continuum mechanics

Vector and tensor (notation, algebra, analysis)
Kinematics (deformation gradient, strain, velocity gradient)
Mechanical and thermodynamical principles (mass balance, force and moment balance, stress, power balance, energy balance, entropy imbalance, free-energy imbalance)
Constitutive theory of elasticity (homogeneous, linear elasticity, Hooke's law, Navier's equation, plane problems)

Part II Eshelby's inclusion problem

Elastic fields (Green's function method, Eshelby's thought experiment, Eshelby's tensor, auxiliary tensor, ellipsoidal inclusion)
Inclusion energy, Eshelby's inhomogeneity

Part III Theory of dislocations

A single dislocation (characters of a dislocation, elastic fields of a dislocation, Peach-Koehler force)
Strengthening mechanism (strain hardening, general point defect-dislocation interaction, solute strengthening, precipitate strengthening, grain boundary strengthening)
Crystal plasticity (slip systems, Schmid factor, continuum models for yielding)

Part IV Fracture mechanics

Linear elastic fracture mechanics (crack energy, crack elastic fields, stress intensity factor, fracture toughness, energy release rate)
Nonlinear fracture mechanics (J-integral, HRR field)

2. Reading List

2.1 Compulsory Readings

1	Lecture notes
2	Tutorial questions
3	Selected articles

2.2 Additional Readings

1	An Introduction to Continuum Mechanics, J. N. Reddy, Cambridge University Press, 2007
2	The Mechanics and Thermodynamics of Continua, M. E. Gurtin, E. Fried and L. Anand, Cambridge University Press, 2010
3	Theory of Dislocations, P.M. Anderson, J.P. Hirth and J. Lothe, Cambridge University Press, 2017
4	Strengthening Mechanisms in Crystal Plasticity, A. Argon, Oxford University Press, 2007
5	Advanced Fracture Mechanics, M. F. Kanninen and C. H. Popelar, Oxford University Press, 1985