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:	**Soft Materials**
Course Code:	**MSE3113**
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)*	**Nil**
Precursors: *(Course Code and Title)*	**AP2102/MSE2102 Introduction to Materials Engineering** **AP2104/MSE2104 Mechanics of Solids** **MA1201 Calculus and Basic Linear Algebra II or** **MA2157 Foundation Mathematics and Statistics or** **MA2176 Basic Calculus and Linear Algebra**
Equivalent Courses: *(Course Code and Title)*	**AP3113 Polymer Engineering**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

Polymers are commonly used in the industry nowadays. As a class of material, polymers possess many distinct characteristics when compared to other traditional materials such as metals and ceramics. This course aims to lay down the foundation knowledge in polymer science and its engineering applications in such a way that the students can identify the appropriate concepts required in given engineering problems and apply them to formulate suitable engineering solutions.

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.	Demonstrate the macromolecular nature of polymers in industrial applications.			√	
2.	Identify the importance of additives in plastics formulations.			√	
3.	Apply the basic theories on the mechanical behaviours of polymers to solve simple engineering (such as deformation and fracture) problems.			√	
4.	Apply basic rheological theories to solve simple problems in melt characterization and polymer processing.			√	
5.	Recognize the environmental issues of using polymers in the industry.			√	
		100%			

** If weighting is assigned to CILOs, they should add up to 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		
Lecture / Tutorial	Explain the key concepts in Mechanics of solids in an interactive manner	√	√	√	√	√		39
Laboratory	To demonstrate some of the key topics learned in Lecture/Tutorial by experimentation			√	√			12
Total(hrs)								51

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: 50%								
Tests	√	√	√	√	√		20	There will be two 1-hour tests, each carries 10%
Lab reports			√		√		20	Students need to complete a number of experiments that demonstrate the principles discussed in lectures/tutorials
Assignments	√	√	√	√	√		10	Take-home or in-class assignments
Examination^: 50% (duration: 2 hours)								
** The weightings should add up to 100%.*							100%	

^ For a student to pass the course, at least 40% 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. Tests	Able to solve numerical problems, and demonstrate the understanding of basic principles	High	Significant	Moderate	Basic	Not even reaching the marginal level
2. Lab reports	Ability to explain the methodology and results from experiments	High	Significant	Moderate	Basic	Not even reaching the marginal level
3. Assignments	Able to solve numerical problems, and demonstrate the understanding of basic principles	High	Significant	Moderate	Basic	Not even reaching the marginal level
4. Examination	Able to solve numerical 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

- Basic concepts of polymer science

  Thermoplastics, thermosets and rubbers. Addition, condensation and network polymerization. Molecular weight distribution and their measurement. Amorphous and crystalline polymers. Stereoisomerism. Copolymers.
- Polymer melt rheology

  Types of flows: Bulk deformation, elongational flow and shear flow. Non-Newtonian flow. Analysis of simple flows. Rheometry: Melt flow index, capillary rheometer, cone and plate rheometer.
- Polymer processing

  Extrusion: Extruder and extrusion dies. Basic consideration on mixing. Single screw and twin screw extruders. Injection moulding: The gate, runner, and mould. Control of pressure, temperature and time. Other processes.
- Rubber elasticity

  Models for rubber elasticity. Rubber springs.
- Viscoelasticity

  Creep, stress relaxation, and dynamic experiments. Boltzmann superposition principle. Time-temperature superposition.
- Yield and fracture

  Shear yielding: Eyring's model, yielding under multiaxial stresses. Impact fracture of polymers. Dynamic critical strain energy release rate.
- Additives

  The need for additives. Types of additives. Properties modifications.
- Polymers and their properties

  Commodity thermoplastics. Fibres. Elastomers. Thermosets. Engineering polymers. Specialty polymers. Polymer blends.
- Environmental considerations

  Plastics recycling. Biodegradable polymers.

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.	N G McCrum, C P Buckley and C B Bucknall, "Principles of Polymer Engineering", 2nd Ed., Oxford Science Publications (1997). (TA455.P58 M334 1997)

2.2 Additional Readings

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

1.	L. H. Sperling, *Introduction to Physical Polymer Science* (4th Edition), John Wiley & Sons, 2006 (Springer e-book)
2.	J R Fried, "Polymer Science and Technology", Prentice Hall (1995). (QD381.F73 1995)
3.	T A Osswald and G Menges, "Materials Science of Polymers for Engineers", Hanser Publishers (1996). (TA455.P58 O68 1996)