Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	**Polymers and Composites and Nano-applications**
Course Code:	**MSE6182**
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)*	**AP6182 Polymers and Composites-with an Introduction to Their Nano-applications (From the old curriculum)**
Exclusive Courses: *(Course Code and Title)*	**AP8182 Polymer and Composites-with an introduction to their Nano-applications (From the old curriculum)**

Part II Course Details

1. Abstract

This course aims to develop basic research skills and introduce recent research developments in polymer science and engineering. This course covers basic knowledge on molecular structure of polymers, physical & chemical properties of polymers and their composites, micromechanic theories of polymer composites, as well as polymer composites with various functions. In addition, up-to-date applications of polymers and composites, as well as advanced nanocomposites including self-healing materials, thermally conductive materials and biomimetic composites will be discussed.

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 molecular nature, polymerization approaches and properties of polymers.	25%	√	√	
2.	Apply experimental techniques to characterize the behavior of polymers and composites.	25%	√	√	√
3.	The innovative design of polymer matrix composites targeting on mechanical reinforcement and thermal conductivity improvement etc.	30%	√	√	√
4.	Identify various functional polymers & their composites, including self-healing materials and biomimetic composites etc.	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	
Lecture	Students will engage in formal lectures to gain knowledge about key concepts; chain structure of polymer molecules, thermal properties of polymers, processing methods, performances, structures and functions of polymer composites.	√	√	√	√	2
Tutorials	Students will engage in tutorial activities to identify strengths and weaknesses and increase their knowledge and skills.	√	√	√	√	1
Assignments	Students will engage in completing the assignments at home to check and consolidate their learnings.	√	√	√		1
Presentation	Students will participate in groups to present a topic related to science and engineering of polymer or polymer composites.	√	√	√	√	3 hrs/wk for 1 or 1.5 weeks (Depending on the size of class)

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				
Continuous Assessment: 40%								
Assignments	√	√	√	√			10%	
Presentation	√	√	√	√			10%	
Middle Term Exam	√	√	√	√			20%	
Examination: (duration: 2 hours)	√	√	√	√			60%	
							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. Assignments	CAPABILITY for SELF-DIRECTED learning and problem solving	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Presentation	ABILITY to explain a topic related to polymer or their composites, including their background, current problems and potential solutions.	High	Significant	Moderate	Basic	Not even reaching marginal level
3. Middle Term Exam	ABILITY to understand structure, properties, performances and functions of polymers.	High	Significant	Moderate	Basic	Not even reaching marginal level
4. Examination	ABILITY to understand structure, properties, performances and functions of polymers and composite materials as a whole.	High	Significant	Moderate	Basic	Not even reaching marginal level

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. Assignments	CAPABILITY for SELF-DIRECTED learning and problem solving	High	Moderate	Basic	Not even reaching marginal level
2. Presentation	ABILITY to explain a topic related to polymer or their composites, including their background, current problems and potential solutions.	High	Moderate	Basic	Not even reaching marginal level
3. Middle Term Exam	ABILITY to understand structure, properties, performances and functions of polymers.	High	Moderate	Basic	Not even reaching marginal level
4. Examination	ABILITY to understand structure, properties, performances and functions of polymers and composite materials as a whole.	High	Moderate	Basic	Not even reaching marginal level

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

1. Keyword Syllabus

- Macromolecules.
- Copolymers.
- Physical characterization techniques in polymer science.
- Viscoelascitity and rubber elasticity.
- Micromechanics for polymer matrix composites.
- Natural and synthetic fibre reinforced polymer composites. Thermosetting and thermoplastic matrices. Fibre properties
- Fibre-polymer interface
- Roles of the interface. Types of interfaces. Characterization of interfaces.
- Behaviour of composite laminae. Density and fibre content. Iso-strain and iso-stress models. Halpin-Tsai equation. Longitudinal tensile strength prediction. Transverse tensile strength prediction. Compression behaviour. Hygrothermal behaviour.
- Mechanics of laminae
- Transformation of stress and strain. Constitutive equations for orthotropic lamina.
- Failure criteria
- Maximum stress theory. Maximum strain theory. Tsai-Wu failure criterion.
- Processing of polymer composites
- Hand lay-up. Vacuum bag and autoclaving. Pultrusion. Filament winding.
- Short fibre composites
- Load-transfer length and critical fibre length. Tensile, fracture and toughness properties.
- Metal matrix and ceramic matrix composites.
- Biomimetic polymer composites
- Polymer nanocomposites
- Carbon nanotube/graphene nanocomposites. Clay-polymer nanocomposites. Intercalation and exfoliation. Potential applications.

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.)

N/A

2.2 Additional Readings

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

1.	F L Matthews and R D Rawlings, "Composite materials: engineering and science", Chapman and Hall (1994). TA418.9.C6 M33 1999
2.	B D Agarwal and L J Broutman, "Analysis and performance of fibre composites, 2nd ed", John Wiley and Sons (1990). TA418.9.C6 A34 2006
3	L H Sperling, Introduction to Physical Polymer Science, 4th Edition, Wiley, 2006. (QD381.S635 2006)
4	I M Ward and J Sweeney, An Introduction to The Mechanical Properties of Solid Polymers, 2nd Edition, Wiley, 2004. (TA455.P58 W36 2004)
5	Journal: 1. H.D. Espinosa, J.E. Rim, F. Barthelat and M.J. Buehler, "Merger of structure and material in nacre and bone –Perspectives on de novo biomimetic materials", Progress in Materials Science 54 (2009) 1059–1100 2. Y. C. Yuan, T. Yin, M. Z. Rong, M. Q. Zhang, "Self healing in polymers and polymer composites. 3. S. C. Tjong, "Structural and mechanical properties of polymer nanocomposites", Materials Science and Engineering R: Reports, 53 (2006) 73-197.