MSE3113: SOFT MATERIALS

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Soft Materials

Subject Code
MSE - Materials Science and Engineering
Course Number
3113

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
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
AP3113 Polymer Engineering

Exclusive Courses
Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Demonstrate the macromolecular nature of polymers in industrial applications.			x	
2	Identify the importance of additives in plastics formulations.			x	
3	Apply the basic theories on the mechanical behaviours of polymers to solve simple engineering (such as deformation and fracture) problems.			x	
4	Apply basic rheological theories to solve simple problems in melt characterization and polymer processing.			x	
5	Recognize the environmental issues of using polymers in the industry.			x	

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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture / Tutorial	Explain the key concepts in polymers in an interactive manner	1, 2, 3, 4, 5	3 hrs/week
2	Laboratory	To demonstrate some of the key topics learned in Lecture/Tutorial by experimentation	3, 4	1 hr/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests	1, 2, 3, 4, 5	20	There will be two 1-hour tests, each carries 10%
2	Lab reports	3, 5	20	Students need to complete a number of experiments that demonstrate the principles discussed in lectures/tutorials
3	Assignments	1, 2, 3, 4, 5	10	Take-home or in-class assignments

Continuous Assessment (%)
50

Examination (%)
50

Examination Duration (Hours)
2

Additional Information for ATs
For a student to pass the course, at least 40% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task
1. Tests

Criterion
Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
2. Lab reports

Criterion
Ability to explain the methodology and results from experiments

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
3. Assignments

Criterion
Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
4. Examination

Criterion
Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Part III Other Information

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.

Reading List

Compulsory Readings

	Title
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)

Additional Readings

	Title
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)