MSE2102: INTRODUCTION TO MATERIALS SCIENCE AND ENGINEERING

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Introduction to Materials Science and Engineering

Subject Code
MSE - Materials Science and Engineering
Course Number
2102

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
Nil

Equivalent Courses
AP2102 Introduction to Materials Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

To develop a basic understanding in the structures and properties of engineering materials.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the classification of materials.	10		x	
2	Correlate materials properties with crystal structures, crystallography, crystal defects.	15		x	
3	Describe the fundamentals of dislocations, plasticity and flow.	15		x	
4	Select and perform basic mechanical testing of materials.	15		x	
5	Construct and use phase diagrams of alloys to explain the properties of alloys.	15		x	
6	Describe common material processing.	15		x	
7	Describe the electrical, magnetic and optical properties of materials.	15		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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will engage in formal lectures to gain key concepts, theories, and applications of materials science and engineering.	1, 2, 3, 4, 5, 6, 7	3 hrs
2	Tutorials	Students will expand and consolidate their knowledge on topics by engaging in exercise practice.	1, 2, 3, 4, 5, 6, 7	1 hr
3	Lab Work	Students will expand and consolidate their knowledge on topics by carrying out lab work.	1, 2, 3, 4, 5, 6, 7	3 hrs

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Quizzes	1, 2, 3, 4, 6	15	
2	Three Lab reports	1, 2, 3, 4, 5, 6, 7	15	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

1. Quizzes

Criterion

Understand the scientific principles and the working mechanisms. Identify and explain how the principles are applied to science and technology for solving physics and engineering problems.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

2. Lab reports

Criterion

Understand the experimental principles and evidence of original thinking, Ability to communicate ideas via written texts.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
3. Examination

Criterion
Demonstrate understanding of the scientific principles and the working mechanisms. Identify and explain how the principles are applied to science and technology for solving physics and engineering problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- Introduction to materials science: Overview of the use of traditional materials. Classification of materials. Current trends of materials research.
- Atomic structure and interatomic bonding: Fundamental concepts. Electrons in atoms. The periodic table. Atomic bonding forces and energies in solid. Primary interatomic bonds. Secondary bonding or Van der Waals Bonding.
- The structure of crystalline solids: Fundamental concepts. Unit cells. Metallic crystal structures. Crystal system. Crystallographic directions. Crystallographic planes.
- Imperfections in solids: Point defects. Equilibrium concentration of point defects. Imperfections due to impurities. Linear defects – dislocations. Interfacial defects. Microscopic examination.
- Mechanical properties of metals and structure of polymers: Stress and strain. Elastic behaviour. Plastic behaviour. Toughness and ductility. Structure of polymers. Hardness tests. Tensile test.
- Dislocations and strengthening mechanisms: Dislocation movement. Stress and energy of dislocation. Force on dislocation. Dislocation interaction. Dislocation multiplication.
- Corrosion of materials: Uniform corrosion. Galvanic corrosion. Pitting corrosion. Intergranular corrosion. Stress corrosion cracking.
- Phase diagrams I: Importance of phase diagrams. Basic concepts. Equilibrium phase diagrams. Phase diagrams of pure substances. Gibbs phase rule and its application. Binary isomorphous system. Experimental determination of phase diagrams. Determination of phase compositions and amounts.

- Phase diagrams II: Solidification with phase diagrams. Equilibrium and non-equilibrium solidification. Binary eutectic system. Development of microstructure in eutectic alloys. Binary, eutectoid and peritectic systems.
- Materials selection and processing: Basic considerations for materials selection. Steel processing. Making of reinforcing bar. Casting. Forming. Machining. Joining. Heat treatment.
- Electrical properties of materials: Electrical conduction. Band model. Semiconductivity. Dielectric behaviour. Ferroelectricity.
- Magnetic and optical properties of materials: Magnetic properties. Optical properties. Luminescence. Photoconductivity. Lasers. Optical fibres.
- Ceramic materials: Ceramic structures, mechanical properties, glasses.
- Polymeric materials: Polymer structures, characteristics, applications, and processing of polymers.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	W D Callister, Jr “Materials Science and Engineering - An Introduction” (An Introduction” (7th ed), John Wiley & Sons (2007).
2	R A Flinn, and P K Trojan, “Engineering Materials and Their Applications” (4th ed), Houghton Mifflin (1990).
3	G E Dieter, “Engineering Design - A Materials and Processing Approach” (2nd ed), McGraw-Hill (1991).