MNE6110: MECHANICAL BEHAVIOUR OF MATERIALS: FROM METALLIC TO BIOMEDICAL/BIOLOGICAL MATERIALS

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Mechanical Behaviour of Materials: From Metallic to Biomedical/Biological Materials

Subject Code
MNE - Mechanical Engineering
Course Number
6110

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
MNE8105 Mechanical Behaviour of Materials: From Metallic to Biomedical/Biological Materials

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to provide a comprehensive treatment of the mechanical behaviour of materials with a balanced mechanics-materials approach, which connects the fundamental mechanisms to the wide range of mechanical properties of different materials under a variety of environments, such as metals, polymers, ceramics, composites, electronic materials, biomedical and biological materials. The unifying thread running throughout is that the nano/microstructure of a material controls its mechanical behaviour. Although this course is designed for the postgraduate students in mechanical, biomedical and materials engineering, it also provides useful knowledge for the practicing engineers involved with mechanical behaviour of materials. This course does not presuppose any extensive knowledge of materials.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Be able to describe and correlate the structure and mechanical properties of soft and hard materials in conventional and bio-medical applications.			x	
2	Be able to describe the key physical principles and microscopic mechanisms behind the mechanical behavior of soft/hard materials in line with their applications in mechanical and bio-medical engineering.		x		
3	Be able to assess the effect of environments on the mechanical properties and performance of soft/hard materials which will be commonly used for mechanical and bio-medical engineering.				x
4	Be able to solve or suggest a solution to a problem related to the mechanical behavior of soft/hard materials that are key to mechanical and biomedical engineering.			x	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	Lecture	Explain key concepts and theories related to the mechanical behaviour of materials.	1, 2, 3, 4	3 hrs/week

2	Homework/Examination	Require students to formulate and solve the scientific problems based on the theories and models discussed during lectures.	1, 2, 4	N.A.
3	Mid-term Report	Require students to identify one key problem related to the mechanical behaviour of materials through literature survey and provide a feasible solution.	1, 2, 3, 4	2 hrs/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Mid-term Report	1, 2, 3, 4	30	
2	Homework	1, 2, 3, 4	20	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to formulate and solve problems with accurate methods.

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

Mid-term Report (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Capacity for self-directed learning to understand/identify the key mechanisms/problems and Ability to explain the methodology and procedure.

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

Homework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Ability to formulate and solve problems with accurate methods; Capacity for self-directed learning to understand the key mechanisms related to mechanical behaviour of materials.

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

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to formulate and solve problems with accurate methods.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Mid-term Report (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Capacity for self-directed learning to understand/identify the key mechanisms/problems and Ability to explain the methodology and procedure.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task
Homework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to formulate and solve problems with accurate methods; Capacity for self-directed learning to understand the key mechanisms related to mechanical behaviour of materials.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- metals, ceramics, polymers, blood vessels, articular cartilage
- plastic deformation of polymers and glasses, criteria for yielding and flow, hardness, plasticity of biological materials
- atomic and electronic point defects, line defects, interfacial and volumetric defects, twinning, grain size strengthening
- theoretical tensile strength, stress concentration, Griffith criterion, linear elastic fracture mechanics, fracture toughness, microscopic mechanisms of fracture
- diffusion creep, dislocation creep, creep in polymers, diffusion-related phenomena in electronic materials, superplasticity

- S-N curves, mean stress effect, fatigue crack propagation, corrosion, radiation damage

Reading List

Compulsory Readings

	Title
1	Marc Meyers and Krishan Chawla, "Mechanical Behavior of Materials", Cambridge University Press, 2009.

Additional Readings

	Title
1	F.A. McClintock and A.S. Argon, "Mechanical Behavior of Materials", Addison-Wesley Publishing Company, Inc., 1966.
2	Y.C. Fung, "Biomechanics: Mechanical Properties of Living Tissues", Springer, 1993.
3	Thomas H. Courtney, "Mechanical Behaviour of Materials", 2nd Ed., Waveland Press, Inc. 2000.