

MNE8105: MECHANICAL BEHAVIOUR OF MATERIALS: FROM METALLIC TO BIOMEDICAL/BIOLOGICAL MATERIALS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

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

Subject Code

MNE - Mechanical Engineering

Course Number

8105

Academic Unit

Mechanical Engineering (MNE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

R8 - Research Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Nil

Equivalent Courses

MNE6110 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 different kinds of materials.		x	x	
2 Be able to describe the key underlying physical principles and microscopic mechanisms behind the mechanical behavior of materials.		x	x	
3 Be able to assess the environmental impacts on the mechanical properties and performance of materials.		x	x	
4 Be able to formulate a problem using the physical principles related to the mechanical behavior of materials.			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	Large Class Activities	During the large-class lectures, the teaching/ learning is focused on mechanical behaviour of materials. The course also deals with the use of fundamental physical principles that govern the mechanical behaviour of materials to solve related engineering problems. Students' performance is assessed through homework, mid-term and final examination.	1, 2, 3, 4	39 hours

Additional Information for LTAs

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

Assessment Tasks / Activities (ATs)

ATs	CILO No.	Weighting (%)	Remarks ("- for nil entry)	Allow Use of GenAI?	
1	Mid-term and In-class Quiz	1, 2, 3, 4	30	-	No
2	Homework	1, 2, 3, 4	20	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

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**

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

Criterion

Each student is required to demonstrate the understanding of the physical principles governing the mechanical behaviour of materials and the ability of selecting a single relevant principle to solve a given engineering problem.

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

Each student is required to comprehend the physical principles and mechanisms governing the mechanical behaviour of materials and be able to solve the engineering problems with the necessary mathematic skills by applying a given physical principle.

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 before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Each student is required to demonstrate the mathematic skills and the ability of selecting multiple principles relevant to solve a given engineering problem related to the 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

Mid-term and In-class Quiz (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Each student is required to demonstrate the understanding of the physical principles governing the mechanical behaviour of materials and the ability of selecting a single relevant principle to solve a given engineering problem.

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

Each student is required to comprehend the physical principles and mechanisms governing the mechanical behaviour of materials and be able to solve the engineering problems with the necessary mathematic skills by applying a given physical principle.

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Assessment Task

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

Criterion

Each student is required to demonstrate the mathematic skills and the ability of selecting multiple principles relevant to solve a given engineering problem related to the mechanical behaviour of materials.

Excellent

(A+, A, A-) High

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Failure

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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	N.A.

Additional Readings

Title	
1	FA McClintock and AS Argon, "Mechanical Behavior of Materials" , Addison-Wesley Publishing Company, Inc, 1966
2	Marc Meyers and Krishan Chawla, "Mechanical Behavior of Materials" , Cambridge University Press, 2009
3	YC Fung, "Biomechanics: Mechanical Properties of Living Tissues" , Springer, 1993