MNE4213: ADVANCED STRUCTURAL MATERIALS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Structural Materials

Subject Code
MNE - Mechanical Engineering
Course Number
4213

Academic Unit
Mechanical Engineering (MNE)

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
Nil

Exclusive Courses
Nil

Additional Information
#Prerequisites which are not part of the Major Requirement are waived for students admitted with Advanced Standing.

Part II Course Details

Abstract

This course is a comprehensive introduction to advanced materials, both current and evolving, used in the aerospace industries. The student will learn about the fundamental mechanisms which lead to the characterisation, properties and applications of such materials and also the processing involved. Topics cover Metallics, Ceramics, Laminates, Composites and an introduction to Nanomaterials and Smart materials. The role that these materials play in the future aerospace industries is critical and the demand for lighter, stronger, reliable and intelligent materials including the more-electric aircraft environment will be central to the theme of this course.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Have a good knowledge of the range of advanced materials from metallics to composites that are involved in aerospace applications together with an appreciation of the processes involved in their manufacture.			x	
2	To be able to describe how these advanced materials are characterized and in terms of their properties be able to select and design materials for particular applications.			x	
3	To use modelling and simulation techniques for the design and application of these advanced materials and smart materials technologies.			x	
4	Present results, analyses and conclusions from experiments or simulations in a written report such that a technically qualified person can obtain a clear understanding of the findings.			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	This includes a combination of lectures and tutorial classes on the role of advanced materials in aerospace engineering, how they are characterized, how their properties are evaluated, the processing involved, how to select materials for specific applications and the role of modelling and simulation for advanced materials design.	1, 2, 3	3 hrs/week
2	Laboratory	Students will carry out practical/simulation exercises to study the important aspects of a range of advanced materials. These will be reported in the form of a short and concise technical report.	3, 4	3 hrs/week for 2 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignments	1, 2, 3	20	2-3 assignments to be submitted.	Yes
2	Laboratory Reports	3, 4	20	2 reports to be submitted	Yes

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

3

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
Assignments

Criterion
To carry out studies of a class of advanced materials using practical and modelling/simulation studies looking into property characterization and applications.

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
Laboratory Reports

Criterion
Ability to explain and interpret the results from exercises involving more advanced materials and to demonstrate an understanding of the role of such materials in current and future aerospace applications.

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

Criterion

To be able to describe the important characteristics and properties of a range of advanced materials, the processing involved, how to choose/design advanced materials for particular applications, to describe the performance and behaviour under particular environmental conditions.

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

Additional Information for AR

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

Part III Other Information

Keyword Syllabus

Overview of current classical aircraft materials and material technologies, Characterisation, properties and application of advanced metallic materials used in aerospace engineering: titanium, aluminium, magnesium alloys, low and high alloy steels, niobium and superalloys, inter-metallics, fibre-metal laminates. Characterisation, properties and applications of advanced composites: Carbon composites, Polymer matrix composites, MMC's, CMC's. An introduction to nanocomposites and smart materials.

In addition to the examination and in-class test, students are required to learn through collaborative lab sessions in order to improve their understanding on strategic thinking, problem solving, team working processes, the relationships and interactions between the fields of knowledge that they have learnt in this and other courses.

Reading List

Compulsory Readings

	Title
1	Aerospace Materials and Material Technologies, Vol 1, Editors: Prasad, Wanhill, Springer, 2017.

Additional Readings

	Title
1	Advanced Aerospace Materials, Ed:Buhl, Springer 1992.