MSE6185: ADVANCED STRUCTURAL MATERIALS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Advanced Structural Materials

Subject Code
MSE - Materials Science and Engineering
Course Number
6185

Academic Unit
Materials Science and Engineering (MSE)

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
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course will be focused on providing comprehensive understanding of scientific concepts and principles used for advanced structural materials, with emphasis on the advanced metallic materials. It will include the microstructures of solids, processing and fabrication, compositional adjustment, metallurgical principles, and development of structure-property correlation. The goal of this course is to achieve that senior and graduate students are able to (1) understand the basic concepts of the advanced structural materials; (2) select and design different structural materials with superior properties for various engineering fields; (3)identify and solve some critical issues in manufacturing and practical applications of these materials

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the development for most common and advanced structural materials	15	x		
2	Describe and explain the typical properties and applications of these materials	15		x	
3	Identify the inner relationship between material properties, processing, and microstructures	25			x
4	Explain the scientific and metallurgical principles used for alloy design and microstructural control	25		x	
5	Apply the scientific and metallurgical principles to solve crucial problems in manufacturing and practical applications of these materials	20		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 with fundamental theories and concepts.	1, 2, 3, 4, 5	2 hrs/week
2	Tutorials	Students will engage in group discussions to improve the understanding of lecture contents.	1, 2, 3, 4, 5	1 hrs/week

3	Peer discussions	Students will engage in structured discussions on the research articles published in top journals to improve the problem-solving abilities.	3, 4, 5	2 hrs/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Quiz	1, 2, 3, 4, 5	20	-	No
2	Assignment	1, 2, 3, 4, 5	20	-	No
3	Mid-term test	1, 2, 3	20	-	No
4	Group presentation	3	10	-	No

Continuous Assessment (%)

70

Examination (%)

30

Examination Duration (Hours)

2

Assessment Rubrics (AR)

Assessment Task

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

Criterion

Ability to understand the fundamental theories and concepts

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

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

Criterion

Capability for self-directed learning to strengthen the understanding of some critical scientific issues

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

Criterion
Ability to understand and master the art of creative thinking towards problem solving

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

Criterion
Ability to identify and explain the inner relationship between material properties and microstructures

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

Criterion
Ability to comprehensively master the scientific principles and use them to solve some theoretical and application 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
Quiz (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Ability to understand the fundamental theories and concepts

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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

Criterion
Capability for self-directed learning to strengthen the understanding of some critical scientific issues

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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

Criterion
Ability to understand and master the art of creative thinking towards problem solving

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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

Criterion
Ability to identify and explain the inner relationship between material properties and microstructures

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

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

Criterion

Ability to comprehensively master the scientific principles and use them to solve some theoretical and application problems

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

(1). Overview of advanced structural materials
(2). States and microstructures of matters:
(a). Atomic structures
(b). Phase diagram and diffusion
(c). Crystal structure and defect
(d). Strengthening and toughening mechanisms
(e). Advanced manufacturing
(3). Typical mechanical properties (elastic, strength, ductility, fracture toughness…)
(4). Non-mechanical Properties (grain growth, corrosive, oxidation…)
(5). Advanced structural materials
(a). Steels
(b). Superalloys and intermetallics
(c). High-entropy alloys
(d). Light-weight alloys
(e). Bulk metallic glasses (BMGs)
(f). Structural-gradient alloys

Reading List

Compulsory Readings

	Title
1	Soboyejo, Winston O., and T. S. Srivatsan, eds. Advanced structural materials: properties, design optimization, and applications. CRC press, 2006.
2	Physical Metallurgy Principles, RE Reed-Hill and R Abbaschian, PWS-KENT Pub, Boston.

Additional Readings

	Title
1	Ferdinand P. Beer, E. Russell Johnston, John T. DeWolf and David F. Mazurek, Mechanics of Materials, 6th edition, McGraw-Hill, New York, 2012, ISBN: 978-0-07-131439-8.
2	Priester L. Grain boundaries: from theory to engineering[M]. Springer Science & Business Media, 2012.
3	Smith, William F. Structure and properties of engineering alloys. McGraw-Hill, 1993.
4	The superalloys: fundamentals and applications by Rogers C. Reed, Cambridge University Press, 2006.

5	Recent papers on nanostructured steels and intermetallic compounds by Profs. CT Liu, MW Chen, and Dr. T. Yang, et al.
6	Recent papers on structural-gradient metallic materials and SMAT materials by Prof. Jian Lu