

MNE8101: SPECIAL TOPICS ON ADVANCED STRUCTURAL MATERIALS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Special Topics on Advanced Structural Materials

Subject Code

MNE - Mechanical Engineering

Course Number

8101

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

Background knowledge in related disciplines is required and course registration will be subject to the approval of the Course Examiner

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

This course will be focused on the understanding scientific and metallurgical principles used for material processing and fabrication, microstructural control, composition adjustment, mechanical and metallurgical property evaluation, and development of structure-property correlation for advanced structural materials (with emphasis on metallic materials). The goal of this course is to achieve that senior and graduate students are able to select and design structural materials with superior properties as strength members used in advanced engineering systems. The materials topics intended to cover in this course will include phase diagram and microstructural control, hardening of structural materials, conventional and nanostructured steels with high strength, bulk metallic glasses (BMGs): Glass forming ability, atomic structures and mechanical properties, high-temperature superalloys, structural-gradient metallic materials, high-temperature refractory metals and alloys, and light-weight Ti-based alloys (including two-phase TiAl intermetallic alloys).

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 DEC-A2 DEC-A3 app.)			
1	Describe scientific and metallurgical principles used for alloy design and microstructural control.		x	x	
2	Describe and apply advanced ferritic steels and nanostructured materials for structural applications.			x	x
3	Learn and apply light-weight and structural-gradient materials for structural applications.			x	x
4	Learn and apply bulk metallic glasses (BMGs) for structural applications.			x	x
5	Learn and apply high-temperature refractory alloys for structural applications.			x	x
6	Learn and apply Ni-based superalloys for structural applications.			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	Lecture on the topics of advanced structured rationale.	1, 2, 3, 4, 5, 6	39 hours

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Quizzes/Test(s)	1, 2, 3, 4, 5, 6	60	-	No
2	Assessment of Term Report	1, 2, 3, 4, 5, 6	40	-	Yes

Continuous Assessment (%)

100

Examination (%)

0

Assessment Rubrics (AR)**Assessment Task**

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

Criterion

Ability to describe the underlying principles of alloy design that can be used for developing structural materials like steels, superalloys, nano-structured materials, bulk metallic glasses, refractory materials, and light-weight materials as well as techniques for producing structural gradient alloys along with their 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

Assessment of Term Report (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Quality of the report with emphasis on relevant and exhaustive literature review on the topic given towards identifying suitable alloy(s) that can be developed for a given application.

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

Quizzes/Test(s) (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Ability to describe the underlying principles of alloy design that can be used for developing structural materials like steels, superalloys, nano-structured materials, bulk metallic glasses, refractory materials, and light-weight materials as well as techniques for producing structural gradient alloys along with their applications.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not even reaching marginal levels

Assessment Task

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

Criterion

Quality of the report with emphasis on relevant and exhaustive literature review on the topic given towards identifying suitable alloy(s) that can be developed for a given application.

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

Phase diagram and microstructural control, hardening of structural materials, conventional and nanostructured steels with high strength, bulk metallic glasses (BMGs): Glass forming ability, atomic structures and mechanical properties, high-

temperature superalloys, structural-gradient metallic materials, high-temperature refractory metals and alloys, and light-weight Ti-based alloys (including two-phase TiAl intermetallic alloys).

Reading List

Compulsory Readings

Title	
1	N.A.

Additional Readings

Title	
1	Atomic structures of bulk metallic alloys (BMGs): Atomic-level structure and structure-property relationship in metallic glasses by Y.Q. Cheng and E. Ma, Progress in Materials Science (2010)
2	Recent papers on bulk metallic Glasses by XJ Liu and CT Liu.
3	Bulk Metallic glasses by C. Suryanarayana and A. Inoue, CRC Publication, 2010.
4	Superplasticity in Metals and Ceramics by TG Nieh et al., Cambridge University Press, 1991.
5	Intermetallic compounds as new structural materials by M. Yamaguchi, Elsevier Publication, 1996.
6	Recent papers on nanostructured ferritic and austenitic steels by CT Liu, MW Chen, MK Miller, ME Fine.
7	Recent papers on structural-gradient metallic materials and SMAT materials by Jian Lu.
8	The superalloys: fundamentals and applications by Rogers C. Reed, Cambridge University Press, 2006.