

MNE8109: THERMODYNAMICS AND KINETICS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Thermodynamics and Kinetics

Subject Code

MNE - Mechanical Engineering

Course Number

8109

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

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to cover the fundamental and advanced topics related to thermodynamics and kinetics of materials for our research postgraduate students, from the statistics mechanics, the thermodynamics laws (first and second laws), phase transition, surfaces and interface, instability to defects in materials.

Course Intended Learning Outcomes (CILOs)

| CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|--|---------------------|--------|--------|--------|
| 1 Understand the principles and fundamentals of thermodynamics and kinetics. | | | x | |
| 2 Able to study the literatures related to thermodynamics and kinetics of materials. | | x | x | |
| 3 Formulate an engineering problem with the principles of thermodynamics and kinetics. | | | x | |
| 4 Apply the principles of thermodynamics and kinetics to solve an engineering problem. | | | 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 | This includes typical lectures on different topics of thermodynamics and kinetics. | 1, 2, 3, 4 | 39 hours |

Assessment Tasks / Activities (ATs)

| ATs | CILO No. | Weighting (%) | Remarks ("- " for nil entry) | Allow Use of GenAI? |
|---------------------------|------------|---------------|---|---------------------|
| 1 In-class quiz and tests | 2, 3, 4 | 20 | At least one mid-term or in-class quiz to be arranged | No |
| 2 Homework | 1, 2, 3, 4 | 20 | 3-4 assignments 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

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

Criterion

Understand the principles and fundamentals of thermodynamics and kinetics, formulate the engineering problems with the above mentioned principles.

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

Able to study the literatures related to thermodynamics and kinetics of materials, Understand the principles and fundamentals of thermodynamics and kinetics, formulate and solve the engineering problems with the above mentioned principles.

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

formulate and solve the engineering problems with the given principles of thermodynamics and kinetics.

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

In-class quiz and tests (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Understand the principles and fundamentals of thermodynamics and kinetics, formulate the engineering problems with the above mentioned principles.

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

Able to study the literatures related to thermodynamics and kinetics of materials, Understand the principles and fundamentals of thermodynamics and kinetics, formulate and solve the engineering problems with the above mentioned principles.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

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Assessment Task

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

Criterion

formulate and solve the engineering problems with the given principles of thermodynamics and kinetics.

Excellent

(A+, A, A-) High

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Part III Other Information**Keyword Syllabus**

- The zeroth, first, second and third laws of thermodynamics; internal energy; entropy; enthalpy; free energy
- Statistic mechanics; probability; temperature; partition function; diffusion
- Transition state theory;
- Phase transition; phase diagrams; phase stability; crystal and glass; solid solution and metallic compounds
- Defects; vacancy; dislocation; surface and interface; fracture

Reading List**Compulsory Readings**

| Title | |
|-------|------|
| 1 | N.A. |

Additional Readings

| Title | |
|--------------|---|
| 1 | Gerald H. Meier, Thermodynamics of surfaces and interfaces: Concepts in inorganic materials; Cambridge University Press. |
| 2 | R.K. Pathria and Paul D. Beale, Statistical mechanics; the 3rd Edition; Elsevier. |
| 3 | Svein Stolen, Tor Grande and Neil L Allan, Chemical Thermodynamics of Materials: Macroscopic and Microscopic Aspects, John Wiley & Sons, Ltd. |
| 4 | U.F. Kocks, A.S. Argon and M.F. Ashby, Thermodynamics and kinetics of slip, Pergamon Press Ltd. |
| 5 | Y. Austin Chang, W. Alan Oates, Materials Thermodynamics, Johns Wiley & Sons, Inc. |
| 6 | Taiji Nishizawa, Thermodynamics of microstructures, 2008 ASM International® |