

## Subject Guide – Mechanical Behaviors and Degradations

<b>Shortened Name</b>	MeBD	<b>Semester</b>	2-2022
<b>Class Time (weekly)</b>	Thurs., 9-12	<b>Lecture hours</b>	3h x 15w
<b>Subject Code</b>	090435110	<b>Assignment and self-study</b>	5h x 15w
<b>ECTS credits</b>	6	<b>Preparation for exam</b>	30
<b>KMUTNB Credits</b>	3(3-0-6)	<b>Total working hours/semester</b>	150

### 1 Revision date of this document, reasons for revision

21.11.2022

### 2 Course description

Stress and Strain; Elastic Properties; Yielding; Material Behavior with Plastic Deformation; Fracture; Crack Growth; Fatigue; Creep; Wear; Failure Analysis; Life Assessment for Engineering Components.

### 3 Lecturers

Asst. Prof. Dr. Karuna Tuchinda

### 4 Expected learning outcomes (in accordance with the MAE program ELOs)

Primary LOs (primary content of class, knowledge is explicitly evaluated (for example, by exams), larger share of overall grade):

- Knowledge and understanding of principles, techniques and methodology related to mechanical behavior and failure (GELO 1)
- Awareness and sensitivity towards an engineer's responsibility for sustainability and aspects such as reliability and safety, engineering's impact on society etc. (GELO 2)
- Ability to write a professional-quality report on a research or problem-solving project (GELO 3)
- Ability to perform a literature research and summary and use to solve engineering problem related to mechanical behavior and failure (GELO5)
- Ability to present a project in front of a professional audience (GELO 6)
- Ability to transform real life problem into a valid engineering problem that can be used for life assessment (GELO 8)

Secondary LOs (not primary content of class, but implicitly taught by application, for example by project work or assignments. Is evaluated, lower share of overall grade)

- Ability to design a methodology based on simulation and design to solve engineering problem related to life prediction (SELO 1)
- Knowledge and understanding of scientific fundamentals relevant for the understanding of the behaviour of materials in engineering applications (SELO 2)
- Knowledge of technical systems and technologies related to mechanical properties testing and failure characterization (SELO3)
- Ability to apply methodology and commercial FE software to simulate engineering problem and to understand the material mechanical behavior and failure under service (SELO 4)
- Knowledge of engineering materials, modes of failure and degradation as well as applicable testing techniques (SELO 7)

Note: These ELOs correspond to the Program ELOs (referenced in parentheses) but are specifically worded for this course by omissions and additions (in *italics*).

## 5 Assessment

Each student will be individually assessed on:

	<b>Total %</b>
<b>Assignment</b>	10
<b>Projects</b>	50
<b>Midterm Exam</b>	25
<b>Final Exam</b>	15
<b>Total</b>	<b>100</b>

## 6 Teaching materials

- Electronic or printed materials may be handed over during the class.

## 7 Books and references

- Mechanical Behavior of Materials- Engineering Methods for Deformation, Fracture and Fatigue, Forth ed., Dowling, N.E., PRENTICE HALL
- Dieter, G.E., Mechanical Metallurgy, Third Ed., McGRAW-HILL International Editions.
- Engineering Materials 1, 4th edition: An Introduction to Properties, Applications and Design, Michael F. Ashby and David R.H. Jones

## 8 Course schedule

Week	Date	Activity, Class Title (unit number)	Evaluation %	Class Hours
1	5 Jan 2022	Lecture, Introduction and Background Knowledge (1)		3.0
2	12 Jan 2022	Lecture, Yielding and Fracture under Combined Stresses(2)	2	3.0
3	19 Jan 2022	Lecture, Fracture(3)	2	3.0
4	26 Jan 2022	Discussion, Project	7.5	3.0
5	2 Feb 2022	Discussion, Project	7.5	3.0
6	9 Feb 2022	Lecture, Fatigue(4)	1.5	3.0
7	16 Feb 2022	Mid-Term Examination	25	
8	23 Feb 2022	Lecture, Fatigue Crack Growth(5)	1.5	3.0
9	2 Mar 2022	Lecture, Creep(6)	1.5	3.0
10	9 Mar 2022	Discussion, Project	5	3.0
11	16 Mar 2022	Lecture, Wear (7)	1.5	3.0
12	23 Mar 2022	Discussion and Lab., Failure Analysis and Life Assessment (8)		6.0
13	30 Mar 2022	Discussion, Project	15	6.0
14	20 Apr 2022	Project Presentation and report	15	3.0
15	27 Apr 2022	Final Examination	15	
<b>(Sums)</b>			100%	45

## 9 Content details

Unit #	Title	Lesson (L) Contents
1	Introduction and Background Knowledge	<ul style="list-style-type: none"> <li>• Mechanical Loading type</li> <li>• Mechanical behavior</li> <li>• Mechanical Failure</li> </ul>
2	Yielding and Fracture under Combined Stresses	<ul style="list-style-type: none"> <li>• Review of complex state of stress</li> <li>• Review of Hook's Law</li> <li>• Yield and fracture criteria</li> </ul>
3	Fracture	<ul style="list-style-type: none"> <li>• State of stress at crack tip</li> <li>• Linear elastic fracture mechanics</li> <li>• LEFM limitation</li> </ul>
4	Fatigue	<ul style="list-style-type: none"> <li>• High cycle fatigue: Mechanism and equations</li> <li>• Improvement of material fatigue resistance</li> <li>• Effect of mean stress</li> </ul>
5	Fatigue Crack Growth	<ul style="list-style-type: none"> <li>• Crack initiation and propagation</li> <li>• Determination of rate of crack propagation</li> <li>• Improvement of crack resistance</li> </ul>
6	Creep	<ul style="list-style-type: none"> <li>• Creep mechanism</li> <li>• Creep test</li> <li>• Life prediction</li> </ul>
7	Wear	<ul style="list-style-type: none"> <li>• Wear mechanism: adhesive, abrasive, fatigue</li> <li>• Introduction to contact mechanics related to surface wear</li> <li>• Wear model and equations: Numerical, Theoretical and Empirical based equations</li> </ul>
8	Failure Analysis and Life Assessment	<ul style="list-style-type: none"> <li>• Design based on mechanical failure.</li> <li>• Life prediction based on bulk and surface material failure</li> <li>• Basic testing and material characterization required for failure analysis.</li> </ul>

## 10 Details on the evaluation of Expected Learning Outcomes

		Assignments	MT-Exam	Final Exam	Project
		10%	25%	15%	50%
<b>GELO1</b>	Knowledge and understanding of principles, techniques and methodology related to mechanical behavior and failure	8 %	20%	10%	10 %
<b>GELO2</b>	Awareness and sensitivity towards an engineer's responsibility for sustainability and aspects such as reliability and safety, engineering's impact on society etc.		3%	3%	5%
<b>GELO3</b>	Ability to write a professional-quality report on a research or problem-solving project				2.5%
<b>GELO5</b>	Ability to perform a literature research and summary and use to solve engineering problem related to mechanical behavior and failure				5%
<b>GELO6</b>	Ability to present a project in front of a professional audience				2.5%
<b>GELO8</b>	Ability to transform real life problem into a valid engineering problem that can be used for life assessment		2%	2%	10%
<b>SELO1</b>	Ability to design a methodology based on simulation and design to solve engineering problem related to life prediction				2.5%
<b>SELO2</b>	Knowledge and understanding of scientific fundamentals relevant for the understanding of the behaviour of materials in engineering applications				5 %
<b>SELO3</b>	Knowledge of technical systems and technologies related to mechanical properties testing and failure characterization				2.5%
<b>SELO4</b>	Ability to apply methodology and commercial FE software to simulate engineering problem and to understand the material mechanical behavior and failure under service				2.5%
<b>SELO7</b>	Knowledge of engineering materials, modes of failure and degradation as well as applicable testing techniques	2%			2.5%