Applied Fracture Mechanics - BMEEOHSMT61

I. Subject Specification

1. Basic Data

1.1 Title

Applied Fracture Mechanics

1.2 Code

BMEEOHSMT61

1.3 Type

Module with associated contact hours

1.4 Contact hours

Type	Hours/week / (days)
Lecture	2
Seminar	1

1.5 Evaluation

Midterm grade

1.6 Credits

4

1.7 Coordinator

name	Dr. Horváth László István
academic rank	Associate professor
email	horvath.laszlo@emk.bme.hu

1.8 Department

Department of Structural Engineering

1.9 Website

https://epito.bme.hu/BMEEOHSMT61
https://fiek2.mywire.org/course/view.php?id=2454

1.10 Language of instruction

hungarian and english

1.11 Curriculum requirements

Compulsory in the Specialization of Structures, Strcutural Engineering (MSc) programme

Optional in the Structural Engineering (MSc) programme

1.12 Prerequisites

Recommended prerequisites:

- FEM for civil engineers (BMEEOTMMS51)

1.13 Effective date

1 September 2022

2. Objectives and learning outcomes

2.1 Objectives

The objective of the subject is the presentation of the basic theories and methods of fracture mechanics, and their application in the field of civil engineering. The basic definitions of fracture mechanics and their mathematical representation, and the basic calculation methods are also introduced. The design methods in Eurocode based on fracture mechanics are presented.

2.2 Learning outcomes

Upon successful completion of this subject, the student:

A. Knowledge

1. Student will learn the basic definitions of fracture mechanics,
2. will learn the cause of cracks and the cause of crack propagation,
3. will learn the methods used for the calculation of the stress state near the cracks,
4. will learn the most important variables of fracture mechanics, and the basic methods for their determination with calculation or tests,
5. will learn the application of the tools of fracture mechanics to structures in civil engineering,
6. will learn the simple and complex methods to determine the structural integrity,
7. will learn about the fatigue cracks.

B. Skills

1. Student will be able to calculate the most important factors of fracture mechanics,
2. will be able to determine the stress intensity factor or J integral near the head of the crack,
3. will be able to decide that how dangerous a crack is with one or multiple parameter analysis,
4. will be able to predict the lifetime of a structural element in case of cyclic loading,
5. will be able to use advanced methods to avoid the fatigue cracks in the structure,
6. will be able to recognize the fracture mechanics in the background of Eurocode.

C. Attitudes

1. Stdent is ready to apply numerical computational tools,
2. is intent on learning and applying the relevant tools of fracture mechanics,
3. is intent on precise and error-free problem solving.

D. Autonomy and Responsibility

1. Student is able to autonomously evaluate instability phenomena and able to autonomously complete design calculations based on the literature,
2. is open to new design procedures, and autonomously evaluates the correctness and applicability of new design procedures.

2.3 Methods

Lectures, exercises, written and oral communications, application of IT tools and techniques, assignments solved individually or, optionally, in teams.

2.4 Course outline

Week	**Topics of lectures and/or exercise classes**
1.	Brief history of fracture mechanics. The microstructural basics of fractures and crack propagation.
2.	Stress functions to analyse the top of cracks (Koloszov-Muszhelisvili-Westergaard model). Stress intensity factors.
3.	Energy methods, *G* parameter, *J* integral. Analysis of plastic crack top.
4.	Laboratory tests, determination of *K*, *G*, *J* and CTOD. Numerical modelling of cracks.
5.	Analysis of quasi-statical effects. Effect of creep and corrosion.
6.	Analysis of cyclic loading.
7.	Analysis of the cracks of quasi-rigid materials (concrete, rocks).
8.	Complex methods – introduction and basics.
9.	Structural integrity of civil engineering structures: from the error evaluating diagrams to the Fitness-for-service methods.
10.	Fracture mechanics for cyclic loading.
11.	Background of the fatigue design in the Eurocode.
12.	Lifetime prediction of existing steel structures.
13.	The proper structural material to avoid rigid cracks: fracture mechanics background, standard and expert methods.
14.	Case studies.

The above programme is tentative and subject to changes due to calendar variations and other reasons specific to the actual semester. Consult the effective detailed course schedule of the course on the subject website.

2.5 Study materials

a) Textbooks:

1. Mushelisvili, N.: Some basic problems of mathematical theory of elasticity, P. Nordhoff,1953.
2. Elementary Engineering Fracture Mechanics, Martinus Nijhoff, 2012
3. Ainsworth, R. A. - Schwalbe, K. H.: Fracture of Materials from Nano to Macro, Elsevier/Pergamon Press, 2007

b) Online materials:

1. lecture materials on the home page of the subject
2. Background documents in support to the implementation, harmonization and further development of the EUROCODES, Scientific and Technical Reports of the Joint Research Centre, European Commission

2.6 Other information

2.7 Consultation

The teachers are available for consultation during their office hours, as advertised on the department website. Special appointments can be requested via e-mail.

This Subject Datasheet is valid for:

Inactive courses

II. Subject requirements

Assessment and evaluation of the learning outcomes

3.1 General rules

The assessment of the learning outcomes specified in clause 2.2. above and the evaluation of student performance occurs via 2 midterm tests.

3.2 Assessment methods

Evaluation form	Abbreviation	Assessed learning outcomes
1. midterm test	ZH1	A.1-A.4; B.1-B.2; C.1-C.3; D.1-D.2
2. midterm test	ZH2	A.5-A.7; B.3-B.6; C.1-C.3; D.1-D.2

The dates of deadlines of assignments/homework can be found in the detailed course schedule on the subject's website.

3.3 Evaluation system

Abbreviation	Score
ZH1	50%
ZH2	50%
Sum	**100%**

Criterion for completion of the subject is to collect at least 50% of the total points in case of both tests. The results are accepted only in the semester they are acquired.

3.4 Requirements and validity of signature

Signature can't be obtained.

3.5 Grading system

Grade	Points (P)
excellent (5)	80% <= P
good (4)	70% <= P <80%
satisfactory (3)	60%<= P <70%
passed (2)	50% <= P <60%
failed (1)	P < 50%

3.6 Retake and repeat

1. The midterm tests can be repeated – once without fee – at a previously determined date given in the course schedule.
2. In case of repetition of the test, the new result will be taken into account for the calculation of the final mark.
3. If the first repetition is also unsatisfactory (failed), then there is no chance to repeat the test again in that semester.

3.7 Estimated workload

Activity	**Hours/semester**
contact hours	14×3=42
preparation for the courses	14×1=14
preparation for the tests	2×24=48
home studying of the written material	16
Sum	**120**

3.8 Effective date

1 September 2022

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Inactive courses