

I. Subject Specification**1. Basic Data***1.1 Title***APPLIED FRACTURE MECHANICS***1.2 Code***BMEEOHSMsFST15-00***1.3 Type*

Module with associated contact hours

1.4 Contact hours

Type	Hours/week / (days)
Lecture	2

1.5 Evaluation

Midterm grade

1.6 Credits

3

1.7 Coordinator

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academic rank	Assistant professor
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1.8 Department

Department of Structural Engineering

1.9 Websiteepito.bme.hu<https://edu.epito.bme.hu/course/view.php?id=5216>*1.10 Language of instruction*

hungarian

1.11 Curriculum requirements

Recommended elective in the Specialization of Structures, Structural Engineering (MSc) programme

*1.12 Prerequisites**1.13 Effective date*

1 September 2025

2. Objectives and learning outcomes

2.1 Objectives

The main goal of this subject is to provide a comprehensive introduction to the fundamental theories and analytical methods of fracture mechanics, with a specific focus on their practical applications in civil engineering. The course covers the essential definitions related to fracture mechanics, along with their mathematical representations, enabling students to understand the underlying principles governing material failure. Additionally, it introduces the fundamental calculation methods used in fracture mechanics to analyze structural integrity and predict potential failures. A significant part of the subject is dedicated to exploring the design methods outlined in the Eurocode, which are based on fracture mechanics principles, ensuring that students gain insight into standardized engineering practices for safe and efficient structural design.

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, 8. will learn about the standard background of fracture mechanics.

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, 7. will be able to select the right steel grade for a given structure, 8. uses computer-aided design software.

C. Attitudes

1. Student is suitable for analytical thinking, 2. is ready to apply numerical computational tools, 3. is intent on learning and applying the relevant tools of fracture mechanics, 4. carries out his/her duties to the best of his/her ability and to a high standard, 5. is open to learning about professional and technological developments and innovations in the field of fracture mechanics.

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. independently revives the necessary basic mathematical knowledge, 3. is open to new design procedures, and autonomously evaluates the correctness and applicability of new design procedures, 4. keeps abreast of legislative, technical, technological and administrative changes in the field, 5. uses cognitive skills to make decisions and to move logically from one idea to another.

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

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-static 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

0

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:

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

Assessment Name (Type)	Code	Assessed Learning Outcomes
1. midterm test	ZH1	A.1-A.4; B.1-B.2, B.8; C.1-C.5; D.1-D.5
2. midterm test	ZH2	A.5-A.8; B.3-B.8; C.1-C.5; D.1-D.5

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

3.3 Evaluation system

Code	Weight
ZH1	50%
ZH2	50%
Total	100%

3.4 Requirements and validity of signature

Signature can't be obtained.

3.5 Grading system

Grade	Score (P)
excellent (5)	$80 \leq P$
good (4)	$70 \leq P < 80\%$
satisfactory (3)	$60 \leq P < 70\%$
pass (2)	$50 \leq P < 60\%$
fail (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	$14 \times 2 = 28$
preparation for the tests	$2 \times 25 = 50$
home studying of the written material	12

3.8 Effective date

1 September 2025

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