BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS
FACULTY OF MECHANICAL ENGINEERING

SUBJECT DATASHEET

I. SUBJECT DESCRIPTION

1. GENERAL DATA

1.1. Subject name (in Hungarian, in English)

Fatigue and fracture ● Fatigue and Fracture

1.2. Neptun code

BMEGEMTNWFF

1.3. Type

study unit with contact hours

1.4. Course types and number of hours (weekly / semester)

course type	number of hours (weekly)	nature (connected / stand-alone)
lecture (theory)	3	-
exercise	1	coupled
laboratory exercise	-	-

1.5. Type of assessments (quality evaluation)

exam

1.6. ECTS

3

1.7. Subject coordinator

name:	Dr. Orbulov Imre Norbert
post:	associate professor
contact:	orbulov@eik.bme.hu

1.8. Host organization

Department of Material Science and Engineering (http://www.att.bme.hu/)

1.9. Course homepage

https://www.att.bme.hu/oktatas/mesterkepzes-msc/

1.10. Course language

english

1.11. Primary curriculum type

mandatory

1.12. Direct prerequisites

Strong prerequisite: -

Weak prerequisite: -

Parallel prerequisite: -

Milestone prerequisite: -

Excluding condition: -

(the subject cannot be taken if you have previously completed any of the following subjects or groups of subjects)

2. AIMS AND ACHIEVEMENTS

2.1. Aim

Mechanical discussion of time-varying load processes of materials and structures. The process of fatigue. High-cycle fatigue, test methods, determination of fatigue limit, durability. The phenomenon of short-cycle fatigue, measurement technique, Manson-Coffin relationship. Combined Wöhler curve. Design to avoid fatigue. Cumulative damage theories. Comparison and application of different fracture mechanics theories in structural design. Analysis of the process of crack propagation. Stable crack propagation. Presentation and mastering of test methods.

2.2. Learning outcomes

Competences that can be acquired by completing the course:

A. Knowledge

- Has a comprehensive knowledge of the formation and course of fatigue failure.
- Aware of the phenomenon of high-cycle fatigue, the concept of fatigue limit and lifetime strength, and the Basquin relationship.
- Understands the mathematical statistics-based evaluation method for high-cycle fatigue tests.
- Understands how to edit security charts and principles.
- Knows the evaluation method for low-cycle fatigue tests.
- Aware of the methodology of design to avoid fatigue, the combined Wöhler curve, and the conditions necessary to avoid fatigue failure.
- Has basic knowledge of cumulative damage theories.
- Aware of the basic fracture mechanical models, the mechanical problems of bodies containing cracks, the concept of the stress concentration factor.
- Knows the concept of stress intensity factor and its critical value, fracture toughness.
- Understands the principles and basic relationships of linearly flexible, allowing small plastic deformation and plastic fracture mechanics.
- Knows the concept of stable crack propagation and the basic methods of life calculation.

B. Ability

- Able to distinguish between different cases of fatigue.
- Defines the limits for successful designs to avoid fatigue.
- Able to edit safety diagrams for individual structures.
- Able to model individual load cases and determine the number of cycles from them.
- Apply design and inspection methods for fatigue to avoid fatigue failure.
- Calculates life expectancy based on cumulative damage theories.
- Calculates the critical stress or crack length that causes unstable crack propagation.
- Determines the critical stress intensity factor of a material assumed to be elastic, also known as the fracture toughness.
- Use the small plastic deformation correction appropriately.

- Determines the critical J-integral value of a plastic material, i.e., its fracture toughness.
- Designs the expected life of a component based on theories of stable crack propagation.

C. Attitude

- Constantly monitors his / her work, results and conclusions.
- Continuously expands his / her knowledge of fatigue and fracture mechanics.
- Open to the use of information technology tools.
- Seeks to learn about and routinely use the tools needed to solve fracture mechanics.
- Develops his / her ability to provide accurate and error-free problem solving, engineering precision and accuracy.
- Publishes his / her results in accordance with his professional rules.
- Publishes his / her opinions and views without offending others.

D. Independence and responsibility

- Collaborates with the instructor and fellow students to expand knowledge.
- Accepts well-founded professional and other critical remarks.
- In some situations, as part of a team, he / she works with his / her fellow students to solve tasks.
- With his / her knowledge, he / she makes a responsible, well-founded decision based on his analysis.
- He / She is committed to the principles and methods of systematic thinking and problem solving.

2.3. Teaching methodology

During the teaching of the subject, the lecture and practice are separated from each other, both in terms of content and methodology. The lectures basically introduce students to the information defined by the knowledge competence elements using the technique of frontal education. The lectures are the main (on-line) available written study materials, they are not enough to achieve the appropriate preparation. Independent practical sessions promote the application and skill-level acquisition of knowledge through the themes following the lectures and the mirrored classroom method. During the exercises, the knowledge previously acquired at home, independently, is solved partly jointly and partly individually with the help of the practice leader.

2.4. Support materials

a) Textbooks

Richard W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 5th edition, John Wiley & Sons, 2012. ISBN 9780470527801

.L Anderson, Fracture Mechanics. Fundamentals and Application. CRC Press, LLC, 1995. ISBN 0849342600

b) Lecture notes

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c) Online materials

http://att.bme.hu/index.php/oktatas/msc-kepzes-targyai/faradas-es-tores/

2.5. Validity of the course description

Start of validity:	2019. September 1.
End of validity:	2025. July 15.

II. SUBJECT REQUIREMENT

3. ACHIEVEMENT CONTROL AND EVALUATION

3.1 General rules

Learning outcomes are assessed on the basis of a year-end written performance measurement (exam). On the one hand, the dissertation focuses on the application of the acquired knowledge, so it focuses on problem recognition and solution, ie practical (computational) tasks must be solved, on the other hand, the required lexical knowledge is required during performance evaluation, the available working time is 90 minutes. Optional partial performance assessment (optional homework): a complex way of evaluating the knowledge, ability, attitude, and independence and responsibility type competence elements of the subject, the form of which is the individual homework.

3.2 Assessment methods

A. Detailed description of mid-term assessments

B. Detailed description of assessments performed during the examination period (if relevant)

Elements of the exam:

1. written partial exam

   obligation: mandatory (partial) exam unit, failing the unit results in fail (1) exam result

   description: Learning outcomes are assessed on the basis of a year-end written performance measurement (exam). On the one hand, the dissertation focuses on the application of the acquired knowledge, so it focuses on problem recognition and solution, ie practical (computational) tasks must be solved, on the other hand, the required lexical knowledge is required during performance evaluation, the available working time is 90 minutes.

2. oral partial exam

   -

3. practical partial exam

   -

4. inclusion of mid-term results

   -

3.3 The weight of mid-term assessments in signing or in final grading

identifier	weight

The condition for signing is that the score obtained in the mid-year assessments is at least **40%**.

3.4 The weight of partial exams in grade (if relevant)

type	weight
written partial exam	100 %
oral partial exam	0 %
practical partial exam	0 %
inclusion of mid-term results	0 %

3.5 Determination of the grade

grade ● [ECTS]	the grade expressed in percents
very good(5) ● Excellent [A]	above 86%
very good(5) ● Very Good [B]	86% .. 86%
good(4) ● Good [C]	71% .. 86%
satisfactory(3) ● Satisfactory [D]	66% .. 71%
sufficient(2) ● Pass [E]	41% .. 66%
insufficient(1) ● Fail [F]	below 41%

The lower limit specified for each grade already belongs to that grade.

3.6 Attendance and participation requirements

Must be present at at least **70%** (rounded down) of lectures.

At least **70%** the exercises (rounded down) must be actively attended.

3.7 Special rules for improving, retaken and replacement

The special rules for improving, retaken and replacement shall be interpreted and applied in conjunction with the general rules of the CoS (TVSZ).

Taking into account the previous result in case of improvement, retaken-improvement:

new result overrides previous result

3.8 Study work required to complete the course

Activity	hours / semester
participation in contact classes	56
mid-term preparation for practices	7
exam preparation	21
additional time required to complete the subject	52
summary	**136**

3.9. Validity of subject requirements

Start of validity: 2019. September 1.

End of validity: 2025. July 15.

4. ADDITIONAL INFORMATION

4.1 Primary course

The primary (main) course of the subject in which it is advertised and to which the competencies are related:

Mechanical modelling

4.2 Link to the purpose and (special) compensations of the Regulation KKK

This course aims to improve the following competencies defined in the Regulation KKK>

a) knowledge

- Student has the knowledge of the scientific theories (mathematical, mechanical, fluid mechanics, thermal and electronic) and computational methods relevant to mechanical engineering research and development.
- Student has the knowledge of modern experimental and numerical modelling techniques.
- Student has the knowledge of modelling and analysis of time-varying processes in machines and mechanical systems.

b) ability

- Student has the ability to communicate and apply new scientific findings.
- Student has the ability to understand and solve problems to be solved and to generate original ideas.
- Student has the ability to select, apply and develop appropriate modelling methods in the field of engineering design and technology.

c) attitude

- Student has the ability to plan and carry out tasks to a high professional standard, either independently or in a team.
- In the course of student's work, Student will explore the possibility of setting research, development and innovation objectives and strive to achieve them.
- Student is open and receptive to new, modern and innovative processes and methods in engineering modelling.

d) independence and responsibility

- Student acts independently and proactively in solving technical problems.
- Student has a demonstrated responsibility for sustainability and environmental awareness.
- Student independently selects and applies relevant problem-solving methods when solving professional tasks.

4.3 Prerequisites for completing the course

Knowledge type competencies	
(a set of prior knowledge, the existence of which is not obligatory, but greatly facilitates the successful completion of the subject)	-
Ability type competencies	
(a set of prior abilities and skills, the existence of which is not obligatory, but greatly contributes to the successful completion of the subject)	-