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| **Fracture Mechanics** |

**Code: MFTMA31G03-EN**

**ECTS Credit Points: 3**

**Evaluation: exam**

Year, Semester: 3rd year/2nd semester

Number of teaching hours/week:

Lecture: **2**

Practice: **1**

**Prerequisites: Technical Mechanics IV. MFMMC34G02-EN,**

**Technology of Structural Materials MFSAT31G02-EN**

**Topics**:

Continuum mechanical approaches to describe the stress-strain circumstances in the vicinity of cracks where there are different constitutive laws. Possible fracture criteria. The plane (stress or strain) theory of elasticity. The basic principles of the theory of linear elastic fracture mechanics (LEFM). LEFM solutions, the concept of the stress intensity factor (SIF). Plastic field estimations at the crack tip. Non-linear fracture mechanics, J-integrals. Residual stress fields in fracture mechanics. Sources of residual stresses. Crack propagation sensitivity index concept and its practical use for quasi-static and cyclic loaded elements. Engineering procedures (R9, EPRI, COD, leak-before-break) for the handling of crack-like defects in engineering structures. NDT techniques and their reliability, applicability in detection of crack-like defects.

**Literature:**

1. Broek, D.: The Practical Use of Fracture Mechanics, Kluwer Academic Publishers, London, 1988.

Recommended:

1. Fred Nilson: Fracture Mechanics – from theory to Application. KTH, 1993.
2. L.P. Pook: Linear Elastic Fracture mechanics for Engineers. Theory and Applications. WIT-Press 2000.
3. Norman E. Dowling: Mechanical Behavior Materials. Engineering methods for deformation, fracture and fatigue. Prentice-Hall International Editions.1993.
4. Richard Hertzberg: Deformation and Frature Mechanics of Engineering Materials. John Willey and Sons.1989.
5. M. Kocak, A.Webster, J.J. Janos, R.A Ainsworth, R. Koers: FITNET Fitness-for Service. Vol. I. and II. ISBN 978.-.3-940923-00-4. 2008.

**Schedule**

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| **1st week:**  **Lecture:** Overviewing the basics of fracture mechanics and their history.  **Practice:** Introduction to fracture mechanics and giving personal tasks to solve it during the semester. | **2nd week:**  **Lecture:** Measuring techniques of fracture mechanics, linear mechanics basic laws, SIF & KIC calculation methods. The basic rules of checking these parameters.  **Practice:** Search results (by Internet) checking & comparing. |
| **3rd week:**  **Lecture:** Calculation methods of the deformation of the crack end area, and the importance of these phenomena in crack growing. Non linear calculation methods & techniques. COD and its measuring.  **Practice:** Searching results (by Internet) checking & comparing. | **4th week:**  **Lecture:** Calculation methods of the deformation of the crack end area, and the importance of these phenomena in crack growing. Non linear calculation methods & techniques. COD and its measuring.  **Practice:** Presenting the results of the task. |
| **5th week:**  **Lecture:** The importance of remaining stress in crack growing phenomena. Own-check methods of fracture mechanics ( R9, EPRI, COD, leak-before-break, etc.) Measuring methods of COD.  **Practice:** Presenting the results of the task. | **6th week:**  **Lecture:** The importance of remaining stress in crack growing phenomena. Own-check methods of fracture mechanics ( R9, EPRI, COD, leak-before-break, etc.). Measuring methods of COD  **Practice:** Presenting the results of the task. |
| **7th week:**  **Lecture:** The applicable material testing (NDT) methods to detect typical failures in raw material or welded joints. Overview of methods and its industrial applications.  **Practice:** Presenting the results of the task. | **8th week:**  **Mid-term test**  **Lecture:** The typical testing methods to detect surface or mid surface failures in a structure. Physical basics of the methods.  **Practice:** Presenting the results of the task. |
| **9th week:**  **Lecture:** The typical testing methods to detect surface or mid surface failures in a structure. Physical basics of the methods.  **Practice:** Presenting the results of the task. | **10th week:**  **Lecture:** X-ray and isotopic NDT methods. Physical basics of the methods.  **Practice:** Presenting the results of the task. |
| **11th week:**  **Lecture:** Ultrasonic testing methods, physical basics.  **Practice:** Presenting the results of the task. | **12th week:**  **Lecture:** Other NDT testing methods, physical basics, limitations.  **Practice:** Presenting the results of the task. |
| **13th week:**  **Lecture:** Crack sensitivity of different structures (case studies) by the affect of kvasi-statical and repetitive stresses.  **Practice:** Case studies and calculation methods, examples.  Presenting the results of the task. | **14th week:**  **Lecture:** Summary of Fracture Mechanics and its importance in design, production and other engineering fields.  **Practice:** Presenting the results of the task |
| **15th week:**  **End-term test** |  |

**Requirements**

**A, for a signature:**

Attendance at **lectures** is recommended, but not compulsory.

Participation in **practice classes** is compulsory. A student must attend the practices and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can’t make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student’s behavior or conduct doesn’t meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the tasks** as scheduled minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

**B, for a grade:**

The course ends with an **exam (ESE)**.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following table:

Score Grade

0-59 fail (1)

60-69 pass (2)

70-79 satisfactory (3)

80-89 good (4)

90-100 excellent (5)

If the score of any test is below 60, the student once can take a retake test covering the whole semester material.