Course guide
295752 - 295EM022 - Structural Integrity and Failure Analysis

Last modified: 03/03/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN MATERIALS SCIENCE AND ADVANCED MATERIALS ENGINEERING (Syllabus 2019). (Compulsory subject).
ERASMUS MUNDUS MASTER'S DEGREE IN ADVANCED MATERIALS SCIENCE AND ENGINEERING (Syllabus 2021). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: FERHUN CEM CANER BASKURT

Others: Segon quadrimestre:
HOSSEIN BESHARATLOO - Grup: T11, Grup: T12
FERHUN CEM CANER BASKURT - Grup: T11, Grup: T12
LUIS MIGUEL LLANES PITARCH - Grup: T11, Grup: T12
ANTONIO MANUEL MATEO GARCIA - Grup: T11, Grup: T12
ORLANDO ONOFRE SANTANA PEREZ - Grup: T11, Grup: T12

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMCEAM-04. (ENG) Realizar estudios de caracterización y evaluación de materiales según sus aplicaciones
CEMCEAM-05. (ENG) Interpretar y aplicar normativas y especificaciones relativas a los materiales y sus aplicaciones

Transversal:
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

Lectures on theoretical and problem-solving issues, together with experimental activities, are given throughout the course. Evaluation is done on the basis of written exams and oral presentations of proposed activities.

LEARNING OBJECTIVES OF THE SUBJECT

The objective of this course is to combine theoretical and practical knowledge of fatigue and fracture in materials, components and structures, as well as methods for evaluating structural integrity. The course pays special relevance to the analysis of cracks and notches in structural design and estimation of service life. It will provide a thorough knowledge in the field of fracture mechanics, with special relevance to its implementation to analyze the mechanical functionality of a material under different service conditions. Another fundamental objective of this course is the description of the general procedures, techniques and precautions to follow in the investigation and analysis of material failures. The stages of the investigation of failure during service will be discussed and the characteristics of the most common causes of breakage will be described.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Hours small group	9,0	6.00
Self study	96,0	64.00

Total learning time: 150 h

CONTENTS

Tema 1. Introduction

Description:
Structural integrity as a field of knowledge. Mechanical design approaches. Fundamentals of elasticity and plasticity. Elastic, elastoplastic, viscoelastic and viscoplastic behavior.

Full-or-part-time: 8h 20m
Theory classes: 3h
Self study : 5h 20m

Tema 2. Fundamentals of fracture

Description:
Theoretical resistance to rupture. Stress concentrators. Local stress. Fracture energy. Fracture condition. Stress-intensity factor and fracture toughness. Fracture modes. Stable fracture. Mixed-mode fracture. Plastic zone in the three fracture modes. Toughness and microstructure. Ductile-brittle transition. Decohesion and cleavage. Ductile fracture: McClintok model. Fracture in laminar composite materials.

Full-or-part-time: 25h
Theory classes: 8h
Laboratory classes: 1h
Self study : 16h

Tema 3. Cohesive fracture, distributed fracture and method of size effect

Description:
Hillerborg's approach. Properties of softening curve. Experimental determination of properties of cohesive cracks. Cohesive fracture compared with effective elastic fracture. Localized deformation. Basic concepts of distributed fracture. Uniaxial and triaxial distributed fracture models. Cohesive fracture compared with distributed fracture. The size effect method. Determination of fracture properties by the size effect method.

Full-or-part-time: 25h
Theory classes: 7h
Guided activities: 2h
Self study : 16h

Tema 4. Fatigue and structural integrity

Description:
Fatigue damage: cyclic deformation, crack nucleation and crack growth. Fatigue design methods. Fatigue failure. Environmetal assisted cracking: hydrogen embrittlement, stress corrosion cracking and corrosion fatigue. Creep deformation and rupture. Creep-fatigue and creep-fatigue crack growth

Full-or-part-time: 50h
Theory classes: 14h
Laboratory classes: 2h
Guided activities: 2h
Self study : 32h

Tema 5. Non-destructive tests

Description:
Magnetic particles. Penetrating liquids. Ultrasonics. X-rays. Induced currents. Other techniques

Full-or-part-time: 8h 20m
Theory classes: 2h
Laboratory classes: 1h
Self study : 5h 20m

Tema 6. Failure in structural components

Description:
Failure analysis techniques. Initial diagnostic. Visual examination. Macro-examination. Micro-examination. Electron microscopy. Chemical analysis.
Failure causes in metallic, polymeric and ceramic components.

Full-or-part-time: 33h 20m
Theory classes: 8h
Laboratory classes: 2h
Guided activities: 2h
Self study : 21h 20m

GRADING SYSTEM

40% Final Exam + 40% Short (midterm) Tests + 20% Guided Activities.
If mean qualification of short tests is above 5, final exam becomes optional. There is no make-up exam in this course.

BIBLIOGRAPHY

Basic:
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- Suresh, Subra. Fatigue of materials. 2nd ed. Cambridge: Press Syndicate of the University of Cambridge, 1998. ISBN 0521578477.
- Hertzberg, Richard W.; Hertzberg, Jason L.; Vinci, Richard P. Deformation and fracture mechanics of engineering materials. 5th ed. New York [etc.]: John Wiley & Sons, cop. 2013. ISBN 9780470527801.
- Broek, David. Elementary engineering fracture mechanics. 4th rev. ed. The Hague [etc.]: Martinus Nijhoff, 1986. ISBN 9024725801.
- Bazant, Zdenek P.; Planas, Jaime. Fracture and size effect : in concrete and other quasibrittle materials. Boca Raton: CRC PRess, cop. 1998. ISBN 084938284X.
- Bazant, Zdenek P. Scaling of structural strenght. 2nd ed. Oxford: Elsevier, 2005. ISBN 0750668490.
- Bazant, Zdenek P.; Cedolin, Luigi. Stability of structures : elastic, inelastic, fracture and damage theories. Singapore [et al.]: World Scientific Publishing, cop. 2010. ISBN 9789814317023.
- Brooks, Charlie R.; Choudhury, A. Failure analysis of engineering materials. New York [etc.]: McGraw-Hill, cop. 2002. ISBN 0071357580.
- ASM handbook. 10th ed. Materials Park, Ohio: AMS International, 1990-.