Module Description, available in: EN

Fatigue Design

General Information

Number of ECTS Credits

3

Module code

TSM_FaDes

Valid for academic year

2024-25

Last modification

2023-09-22

Coordinator of the module

Federico Bosi (SUPSI, federico.bosi@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Mathematics, Calculus and Mathematical Analysis
- Linear algebra and analytical geometry
- Material Science and Engineering
- Solid Mechanics

- Basics of mechanics of composite materials
- Basics of computational mechanics, including finite element methods

Brief course description of module objectives and content

The course deals with fundamental and technical issues associated with designing and maintaining structures that resist failure from cyclic loading. Students will be taught the principles of fatigue testing and analyzing fatigue failures of materials, addressing the questions of how fatigue behaviour is characterized, how fatigue failure is predicted, which physical mechanisms are responsible for fatigue initiation and propagation in various materials, with particular attention to metals and structural alloys, and how such behaviour is related to the microstructure of the material.

This course will also introduce key applications of fatigue design in industry, including failure analysis, fatigue life calculations, experimental techniques and destructive and non-destructive methods of damage detection and characterization.

Aims, content, methods

Learning objectives and acquired competencies

- Understand the theory of fracture mechanics applied to brittle, ductile and quasi-brittle materials;
- Know the main experimental techniques for the characterization of the properties that characterize the crack onset and propagation;
- Understand the fatigue phenomenon of materials, including the factors that affect the residual life of structures under cyclic loading and analytical methods for the analysis of fatigue problems;
- Use computational mechanics as a tool to solve fracture mechanics problems;
- Apply the knowledge of fatigue and fracture mechanics for the design of structures and investigation of the causes of structural failure;

Contents of module with emphasis on teaching content

Introduction to Fracture Mechanics

Linear Elastic Fracture mechanics

- Griffith's analysis, 1st law of thermodynamics and crack growth, Energy release rate (ERR)
- Stress analysis and stress intensity factor (SIF). Failure modes (mode I, II and III)
- Relation between the SIF and ERR
- Mixed-mode propagation
- Plane stress, plane strain, R-curve, and stability of the propagation
- Experimental determination of the Fracture toughness: standard and non-standard methods

Elasto-plastic fracture mechanics

- Crack opening displacement (COD)
- J integral
- Relation between J-integral, COD and ERR

Fracture in composite materials

- Interlaminar fracture
- Intralaminar fracture
- Failure criteria

Fatigue of metals and composites

- Fatigue limit
- Factors affecting the crack propagation
- Fatigue of composite materials
- Experimental assessment of the fatigue behaviour

Computational fracture mechanics

- Determination of the SIF
- Determination of the J-Integral
- Virtual Crack Closure technique
- Cohesive elements

Teaching and learning methods

- Lectures in presence
- Tutorial in presence
- Self-study

Literature

Assessment

Certification requirements

Module uses certification requirements

Certification requirements for final examinations (conditions for attestation)

There are no conditions to be admitted to the final exam, but students are strongly encouraged to actively participate in the lectures and tutorials.

The final exam is given in written form, and it accounts for 100% of the course evaluation.

Basic principle for exams

As a rule, all the standard final exams for modules and also all resit exams are to be in written form

Standard final exam for a module and written resit exam

Kind of exam

written

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

WiFi off

Other permissible aids

The formula sheet provided by the module coordinator

Special case: Resit exam as oral exam

Kind of exam

oral

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

WiFi off

Other permissible aids

The formula sheet provided by the module coordinator