Fatigue and Fracture (3 ECTS)

Professor(s): Dr. Eric Martin and Dr. Thierry Palin-Luc

Location of courses: ENSEIRB-MATMECA Talence

Language: English

Distribution of courses: 24h of lectures

Description:

The long term durability of structures is an important challenge for engineers. Detection methods show that many cracks may be present within a structure. Fracture mechanics allows deciding whether these cracks can be tolerated without risk or whether it is necessary to repair the part. There are two main objectives of the course: i) introduce the main concepts of rupture and fatigue used for damage tolerance design of structures and ii) the basic for modeling and designing structures against fatigue crack initiation. Indeed the damage tolerance methodology is used in aeronautics and some other industrial sectors but cannot be always used. This is for instance the case in automotive industry for designing safe life structures.

1. Linear elastic fracture mechanics (12h – E. Martin)

- Stress field singularity (asymptotic field in the vicinity of a crack tip)
- Stress intensity factor and Irwin criterion
- Strain energy release rate and Griffith criterion
- More on: crack propagation in mixed mode, interface cracks, three-dimensional aspects, mechanical tests for fracture testing of ceramics and metallic materials, fatigue crack propagation (Paris law)

2. Crack initiation under multiaxial fatigue in metallic materials (12h – T. Palin-Luc)

- Introduction (techno-economic issues)
- Basics and Terminology (general notation, SN curve, loading path, proportional and non-proportional loadings)
- Fatigue test (driving methods and counting tests: the staircase, cumulative frequency)
- Physical basis of fatigue crack initiation in polycrystalline materials
- Multiaxial fatigue criteria (Different families: Empirical (for the record), critical plane (constraints, energy), global (energy, using invariants); three examples are detailed: Crossland (macroscopic approach to stress), Dang Van (approach with change of meso-macro scale), LAMEFIP (non-local energy approach)
- Influence of various factors on crack initiation
- Some elements for variable amplitude (cycle counting method, damage accumulation)

Evaluation:

First session

First part: Linear elastic fracture mechanics → Final Assignment (2h) - coef. 0.5

2nd part: Crack initiation under multiaxial fatigue in metallic materials → Final Assignment (2h) - coef. 0.5

Second session

First part: Linear elastic fracture mechanics → Final Assignment (2h) - coef. 0.5

2nd part: Crack initiation under multiaxial fatigue in metallic materials → Final Assignment (2h) - coef. 0.5