

**ON-LINE**  
**Fatigue and Fracture Mechanics**  
**19th-20th September 2024**



**ABOUT THE COURSE**

The course begins by reviewing those definitions suitable for calculating the stress/strain quantities commonly used to perform the fatigue assessment. Pivotal concepts which should always be kept in mind when designing components against fatigue are summarised (mainly considering uniaxial and torsional situations). The multiaxial fatigue assessment problem is then investigated in great detail, by focusing attention on both the high- and the medium-cycle fatigue regime. The procedures suitable for estimating uniaxial/multiaxial fatigue damage both in notched and in welded components is explained, by focusing attention on the most efficient ways to estimate fatigue strength by post-processing Finite Element results.

Subsequently, following a general introduction to Linear Elastic Fracture Mechanics, the course will go on to explain the importance of crack/flaw analysis in structural design and safety assessment, with this being done by considering both static and fatigue situations. It will give a deep understanding of the major results and criteria underpinning modern fracture mechanics, the assumptions behind them and important limitations. Attendees will gain a better understanding of material selection for fatigue and fracture resistance and learn about codified procedures for flaw evaluation.

**WHO SHOULD ATTEND**

Engineers and scientists involved in the design, operation and assessment of both onshore and offshore structures.

**COST**

The registration fee of the workshop will be £695 + VAT (UK ONLY) which includes course notes.

**PAYMENT**

Payments can be made by cheque (made payable to ASRANet Ltd.) or bank transfer. Please enquire for details.

**CONTACT**  
ASRANet Limited

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# PROGRAMME

*All timings are in BST (GMT +1)*

**Thursday 19<sup>th</sup> September 2024**

## **FATIGUE AND FRACTURE OF PLAIN, NOTCHED, AND WELDED COMPONENTS**

### **08:00- 09:30 LECTURE 1: FUNDAMENTALS**

Introduction, basic definitions, crack initiation mechanisms, SN curves, mean stress effect in fatigue, factors affecting the fatigue behaviour of metals.

### **09:30-09:45 BREAK**

### **09:45 – 11:15 LECTURE 2: VARIABLE AMPLITUDE & NOTCHES**

Variable Amplitude Fatigue, Cycle counting, fatigue damage under variable amplitude fatigue loading, notch fatigue, fatigue strength reduction factor, fatigue under torsion, Theory of Critical Distances

### **11:15-11:45 LUNCH**

### **11:45- 13:15 LECTURE 3: MULTIAXIAL FATIGUE**

Introduction to multiaxial fatigue, the Modified Wöhler Curve Method, designating notched components against multiaxial fatigue

### **13:15- 13:30 BREAK**

### **13:30-15:00 LECTURE 4: FATIGUE OF WELDED JOINTS**

Stress quantities used to assess welded structures, fatigue assessment under uniaxial loading as well as under torsional loading, multiaxial fatigue assessment of welded connections.

**Friday 20<sup>th</sup> September 2024**

## **LINEAR ELASTIC FRACTURE MECHANICS (LEFM)**

### **08:00- 09:30 LECTURE 1: INTRODUCTION AND IRWIN'S EQUATIONS**

Linear elastic stress, Hooke's law, Mode I/II/III loading, Singularities and stress fields, Irwin's equations, Shape factor

### **09:30-09:45 BREAK**

### **09:45-11:15 LECTURE 2: FRACTURE TOUGHNESS**

Static assessment according to LEFM, fracture toughness, plane stress vs. plane strain problem.

### **11:15-11:45 LUNCH**

### **11:45-13:15 LECTURE 3: SCALE EFFECT AND LIMITATIONS OF LEFM**

Scale effect, definition of critical distance  $a_0$ , continuum vs. linear elastic fracture mechanics.

### **13:15- 13:30 BREAK**

### **13:30-15:00 LECTURE 4: LEFM AND FATIGUE LOADING**

Fundamental definitions, crack growth rate, Paris' diagram and Region I, II, and III, fatigue assessment according to LEFM.

## **ABOUT THE LECTURER:**

### **Professor Luca Susmel**



Luca Susmel studied his undergraduate degree in the Department of Mechanical Engineering at the University of Padova, Italy, and completed his PhD between Padova and Dublin, Ireland.

From 2001 to 2011 he spent at least six months every year lecturing and doing research in the Department of Mechanical and Manufacturing Engineering at Trinity College, Dublin. In 2005, he was appointed Associate Professor in Structural Integrity at the University of Ferrara, Italy. He joined the Sheffield Department of Civil and Structural Engineering in 2011 to continue his research on the fatigue and fracture behaviour of engineering materials, components and structures.

Since 1998 Luca has focussed his attention mainly on problems related to the structural assessment of engineering materials and components. By working both in Italy (University of Padova, University of Ferrara, University of Udine), in Ireland (Trinity College, Dublin) and in the UK (University of Sheffield) he has devised several novel engineering methods suitable for designing components (experiencing stress concentration phenomena of all kinds) against static, dynamic, and fatigue failures. Luca's modus operandi involves taking a conjoint theoretical and experimental approach to cracking problems and all the design methods he has formalised so far have been fully validated through systematic experimental work. Luca has unique expertise in designing notched and welded components against constant and variable amplitude multiaxial fatigue.

The work done in the above research areas has led to a large number of scientific articles published in international peer-reviewed scientific journals as well as to a book devoted to multiaxial fatigue assessment. His scientific papers have attracted significant interest from the international scientific community, as it is evidenced by his h-index as well as by the total number of citations. He is a member of the Editorial Boards of the two leading international journals in the fatigue and fracture field, namely "International Journal of Fatigue" and "Fatigue & Fracture of Engineering Materials & Structures". Luca is also the Associate Editor of "Frattura ed Integrità Strutturale: The International Journal of the Italian Group of Fracture" and the Editor-in-Chief of "Theoretical and Applied Fracture Mechanics" (published by Elsevier) which is one of the top journals in the fracture mechanics field.

In terms of the transfer of his research outcomes into engineering practice, in recent years Luca's expertise has been sought on many occasions by a number of European and non-European structural engineering companies that have successfully applied the approaches developed by Luca to design real components and structures.

Luca's work has applications beyond traditional structural civil engineering. For example, in the past, he collaborated with General Motors (via American company ADACS Inc.) on the fatigue design of engines, and with Italian Company Filippi on the determination (in their Olympic medal winning boats) of the loads being applied by athletes during rowing.

## **PAST PARTICIPANTS**

- Atkins, UK
- Apollo, UK
- BAE Systems, UK
- Bayards, Netherlands
- Cadent, UK
- Combifloat Systems BV, Netherlands
- Conoco Phillips Oil and Gas, UK
- Crondall Energy, UK
- EDF Energy, UK
- Lloyds Register, UK
- LOC, UK
- Malin Group, UK
- Navantia, Spain
- Petrofac, UK
- Royal Roos, Netherlands
- Schlumberger, Netherlands
- Shell, UK
- TUV Reinland, Germany
- Ventient Energy, UK