# JCSS Continuing Education & Advanced School

## Probability Theory, Risk Assessment & Structural Reliability and Probabilistic Model Code

Organized by the Joint Committee on Structural Safety (JCSS): www.jcss.byg.dtu.dk

## Increased interest in risk and reliability

Methods of reliability, risk and safety assessment are increasingly gaining importance as decision support tools in various fields of engineering. In order to utilize these methods and to exploit their potential in industrial applications, an understanding of the fundamental principles is necessary. The Advanced School aims at educating engineers and researchers to work more efficiently in supporting decision makers and clients for a sustainable societal development.

## JCSS

The JCSS is a committee in the field of Structural related Risk and Reliability, acting on behalf of the Liaison Committee of the following five international professional associations:

- CIB International Council for Research and Innovation in Building and Construction
- ECCS European Convention for Constructional Steelwork
- fib International Federation for Structural Concrete
- IABSE International Association for Bridge and Structural Engineering
- RILEM Reunion internationale des Laboratoires et Experts des Materiaux

The goals of the JCSS are:

- To improve the general knowledge and understanding within the fields of safety, risk, reliability and quality assurance, for all types of civil engineering and building structures, on the basis of sound scientific principles and with an open eye for the applications in practice.
- To take care that inter-associational pre-normative research in the field of Risk and Reliability is performed in an effective and adequate way

## JCSS Advanced School description

The JCSS Continuing Education and Advanced School provides a deep and thorough insight in the latest developments in the concepts and tools for probabilistic structural reliability engineering and risk informed decision making. The advanced school consists of 3 courses which will be held consecutively:

**Part 1: Probabilistic Modelling and Risk Analysis in Engineering (15.06.2015 - 19.06.2015, Technical University of Denmark, Lyngby, Denmark)**
**Part 2: The JCSS Probabilistic Model Code (31.08.2015 to 05.09.2015, Ghent University, Belgium)**
Part 3: Risk Informed Decision Making and Decision Analysis (to be announced later)

## Benefits

The participants benefit by becoming able to master the methods of reliability, risk and safety assessment for engineering projects. Furthermore, the participants can offer clients new services in the perspective of benefit and risk informed decision support.

## Who should attend?

Engineers involved in probabilistic structural analysis, design and reliability assessment, as well as engineering supervisors and managers will benefit from this course. Further, PhD students and academics working in the field of structural risk assessment will profit from this course. Participants are expected to have basic knowledge on basic probability theory, statistics, linear algebra and elementary structural analysis (static/dynamic).

# Information and course plan Part 1
## Probabilistic Modelling and Risk Analysis in Engineering

### Time and Location

The course on Probabilistic Modelling and Risk Analysis in Engineering will be held from the 15.06.2015 to the 19.06.2015. The course location will at the Technical University of Denmark (DTU).

### Learning methods and activities

Learning methods and activities comprise lectures, practical exercises and self-studies. Self-study assignments will typically consist of calculations that develop understanding of the materials presented in class. Participants will be made familiar with the state-of-the-art computational methods and software in this field.

### Evaluation and Diploma

Course Diplomas are issued by the JCSS on the basis of active course participation and a positive evaluation of the provided material by the participant. 3 ECTS points will be rewarded for the course.

### Course materials

Course compendium, books, selected research reports and papers from journals and conferences.

### Lecturers

- Michael H. Faber
  Professor of Risk and Safety
  Head of the Department of Civil Engineering, Technical University of Denmark, Denmark
- Sebastian Thöns
  Associate Professor of Engineering Decision Analysis
  Department of Civil Engineering, Technical University of Denmark, Denmark
- Dr. Matthias Schubert
  CEO of Matrisk, Switzerland
- Dr. Harikrishna Narasimhan
  COWI, Denmark

### Costs and registration

The attendance fee is 1900,00 € per participant and includes lecture materials. Food and drinks between the lectures are provided. A reduced attendance fee of 900,00 € applies to PhD students. Registration is required via email to Sebastian Thöns (sebt@byg.dtu.dk) until the 31.03.2015.

## Course plan

| **DAY 1** | | | |
|---|---|---|---|
| **Morning** | | **Afternoon** | |
| 8:30-10:30 | Opening<br>• Motivation<br>• Overview<br>• Literature and Aims | 14:00-15:30 | Presented exercises |
| 11:00-13:00 | Probability theory<br>• Definition of Probability<br>• Set Theory<br>• Axioms of Probability Theory<br>• Conditional Probability<br>• Bayes' Rule | 16:00-17:30 | Self-study exercises |

| **DAY 2** | | | |
|---|---|---|---|
| **Morning** | | **Afternoon** | |
| 8:30-10:30 | Uncertainties and random variables<br>• Sources of uncertainties<br>• Characteristics of uncertainties<br>• Random variables | 14:00-15:30 | Presented exercises |
| 11:00-13:00 | Properties of random variables Distributions<br>• Expectation Operator<br>• Random Vectors and Joint Moments<br>• Conditional Distributions and Conditional Moments<br>• Probability Density and Distribution Functions<br>• The Central Limit Theorem<br>• Derived Distributions | 16:00-17:30 | Self-study exercises |

| **DAY 3** | | | |
|---|---|---|---|
| **Morning** | | **Afternoon** | |
| 8:30-10:30 | Random processes and probabilistic model building<br>• The Poisson Counting Process<br>• Continuous Random Processes<br>• Stationarity and Ergodicity<br>• Extreme Value Distributions<br>• Probability Distributions in Statistics<br>• Estimators for Sample Descriptors<br>• Method of Moments<br>• Method of Maximum Likelihood | 14:00-15:30 | Presented exercises |
| 11:00-13:00 | Regression analysis<br>• Linear regression analysis<br>• Coefficient of Determination<br>• Bayesian regression analysis | 16:00-17:30 | Self-study exercises |

| **DAY 4** | | | |
|---|---|---|---|
| **Morning** | | **Afternoon** | |
| 8:30-10:30 | Structural reliability<br>• Failure Events and Basic Random Variables<br>• Linear Limit State Functions and Normal Distributed Variables<br>• FORM<br>• Simulation methods | 14:00-15:30 | Presented exercises |
| 11:00-13:00 | Risk analysis and decision making<br>• Risk Assessment in Engineering<br>• The Decision / Event Tree<br>• Decisions Based on Expected Values<br>• Decision Making Subject to Uncertainty<br>• Bayesian Decision Analysis<br>• Engineering decision problems | 16:00-17:30 | Self-study exercises |
| **Evening** | | | |
| 18:00-19:00 | Practical examples 1 | | |

| **DAY 5** | | | |
|---|---|---|---|
| **Morning** | | **Afternoon** | |
| 8:30-10:30 | System risks modelling<br>• Structural system modelling<br>• Logical systems<br>• Bayesian networks<br>• Vulnerability<br>• Robustness<br>• Resilience | 14:00-15:30 | Presented exercises |
| 11:00-13:00 | Applications<br>• Code calibration<br>• Monitoring and inspection planning | 16:00-17:30 | Self-study exercises |
| **Evening** | | | |
| 18:00-19:00 | Practical examples 2 | | |

# Information and course plan Part 2
## Structural Reliability and JCSS Probabilistic Model Code

### Time and Location

The course on Structural Reliability and JCSS Probabilistic Model Code will be held from 31.08.2015 to 05.09.2015. The course location is Ghent University, Belgium.

### Learning methods and activities

Learning methods and activities comprise lectures, practical exercises and self-studies. Self-study assignments will typically consist of calculations that develop understanding of the materials presented in class. Participants should bring their own case study. Participants will be made familiar with the state-of-the-art computational methods and software in this field.

### Evaluation and Diploma

Course Diplomas are issued by the JCSS on the basis of an active course participation and a positive evaluation of the provided material by the participant. 3 ECTS points will be rewarded for the course.

### Course materials

Course compendium, books, selected research reports and papers from journals and conferences.

### Lecturers

A. Der Kiureghian
Professor of Civil Engineering, University of California,
Berkeley, USA

A.C.W.M. Vrouwenvelder
TNO Department Structural Reliability, Emeritus Professor TU Delft
The Netherlands

J. D. Sørensen
Professor, Department of Civil Engineering
Aalborg University, Denmark

R.D.J.M. Steenbergen
TNO Department Structural Reliability, Visiting Professor Ghent University
The Netherlands / Belgium

R. Caspeele
Professor of Structural Reliability,
Ghent University, Belgium

### Costs and registration

The price is 1800,00 € per participant and includes lecture materials. Food and drinks between the lectures are provided. A special reduced price of 450,00 € is foreseen for PhD students. Registration is required via e-mail to R.D.J.M. Steenbergen (raphael.steenbergen@tno.nl) until 01.06.2015.

## Course plan

| **DAY 1** | |
|---|---|
| **Morning** | **Afternoon** |
| • Basic aspects of structural safety, safety formats and partial factors<br>• Life-cycle optimization and target reliabilities | Time Independent Reliability Methods<br>• Level III calculations (numerical integration, Monte Carlo)<br>• Level II calculations (FORM, SORM)<br><br>Case studies |

| **DAY 2** | |
|---|---|
| **Morning** | **Afternoon** |
| Time Independent System Reliability Methods<br>• Parallel systems<br>• Series systems<br>• Combined systems<br>• Stochastic Finite Element Method (SFEM) | Time Independent System Reliability Methods<br>• Stochastic Finite Element Method<br><br>Case studies |

| **DAY 3** | |
|---|---|
| **Morning** | **Afternoon** |
| Time Dependent System Reliability Methods, random vibrations<br>• Spectral analysis<br>• Response spectra of linear systems<br>• Response spectra of non-linear systems<br>• Finite Element Methods (FEM)<br>• Time domain analysis | Time Dependent System Reliability Methods, static analysis<br>• Outcrossing Approach<br>• Ferry Borges-Castanheta<br>• Implementation in Codes |

| **DAY 4** | |
|---|---|
| **Morning** | **Afternoon** |
| Codes<br>• Level I calculations, partial factors, combination of actions<br>• Code calibration | Case studies |

| **DAY 5** | |
|---|---|
| **Morning** | **Afternoon** |
| Seismic risk analysis<br><br>Case studies | • Wind load<br>• Snow Load<br><br>Case studies |

| **DAY 6** | |
|---|---|
| **Morning** | **Afternoon** |
| Loads:<br>• Life loads<br>• Impact loads<br>• Traffic loads<br>• Fire<br>• Safety assessment of existing structures | • Resistance modeling<br>  ○ Concrete<br>  ○ Steel/Fatigue<br>  ○ Timber<br>• Probabilistic modeling of deterioration<br>Robustness of structures |