

# RELIABILITY – BASED OPTIMIZATION

PhD Studies, Summer Semester, Academic year 2021/2022

## LECTURER

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## DESCRIPTION

1. Due to current restrictions the Reliability-based Optimization classes are provided online:  
<https://enauczanie.pg.edu.pl/moodle/course/view.php?id=19586>

This is a subject's homepage, provided at the GUT e-learning platform (eNauczanie PG) to be permanently supplemented with new contents.

Please, visit the site permanently, to broaden your overview in the field.

2. The course consists of five meetings:

Date	Day of the week	Hours	Room
2022-02-28	Monday	16:15-19:00	eNauczanie
2022-03-07	Monday	16:15-19:00	eNauczanie
2022-03-14	Monday	16:15-19:00	eNauczanie
2022-03-21	Monday	16:15-19:00	eNauczanie
2022-03-28	Monday	16:15-19:00	eNauczanie

3. The lecture language is English. Presentation form: webinar meetings

4. The lecture presence is the major assessment criterion, thus it will be checked. In exceptional cases a distinct assessment is allowed, upon direct contact with the Lecturer.

## CONSULTING

The standard, personal consulting is highly limited now, thus any request of this kind should be announced by an e-mail contact.

Such a request of a direct conversation will result in a meeting-type webinar, allowing its participants to communicate.

Please, submit such requests as soon as possible (ASAP), we will plan the meeting in a possible, convenient term.

The standard personal meeting is possible upon request, while all the restrictions are held.

## PRELIMINARY CONTENTS (UPDATES POSSIBLE)

Remark:

the schedule can be modified to meet the participants' expectations. Individual consulting is possible as well, in the domain of the problems worked out by the course participants

## **PRELIMINARY CONTENTS (UPDATES POSSIBLE):**

### 1. Introduction

Structural Codes. Uncertainty. Basic Variables. Types of Uncertainty.

### 2. Fundamentals of probability theory.

Random variables. Parameters of random variables – moments. Sample parameters.

### 3. Univariate random variables.

Uniform distribution. Normal (Gaussian) distribution. Logarithmic normal distribution. Gamma distribution. Extreme type I - Gumbel distribution (Fisher-Tippett type I). Extreme type II - Fréchet distribution (Fisher-Tippett type II). Extreme Type III - Weibull distribution. Poisson distribution.

### 4. Stochastic mechanics methods.

Random fields discretization methods. Point discretization methods. Average discretization methods. Series expansion methods. Selection of the random field mesh. Generation of random variates. Stochastic Finite Element Methods.

### 5. Monte Carlo methods

Direct Monte Carlo method. Stratified sampling and Latin Hypercube Sampling. Importance sampling and search techniques.

### 6. Structural reliability.

Fundamental case. Limit states - definition of failure. Reliability index. First-Order Second-Moment reliability index - linear limit state functions. Nonlinear limit state functions.

### 7. Random imperfections

Imperfections of cross-sectional geometry. Welded cross-sections.

### 8. Imperfection of structural elements

Imperfections of axes and middle planes of elements. Impact of geometric imperfections on structural strength. Limit load estimation considering geometric imperfections.

### 9. Simulation of discrete random fields.

Theoretical background. Simulation algorithm. Accuracy analysis of simulated random fields.

### 10. Probabilistic sensitivity of limit states of structures.

Fundamental case description. Probabilistic sensitivity of engineering systems.

### 11. Response surface methodology

Response Surface Methodology joint with FEM software. RSM using a polynomial approximation. RSM using a Ratio of Polynomials Surface (RPS) approximation

### 12. Structural loads

Load types. General load models Dead load. Live load in buildings. Sustained (Arbitrary Point-in-Time) live load. Live load for bridges. Environmental loads

### 13. Load combinations

Time variation. Borges model for load combination. Turkstra's rule. Load coincidence method

### 14. Mechanical vibrations due to random excitations

Markov processes. Upcrossing rates. Single-degree-of-freedom system response. Mean and variance of response. White noise approximation, multi-degree-of-freedom response, Equations of motion. Covariance analysis. Filtered white noise excitation

### 15. Human errors

**BIBLIOGRAPHY:**

1. Thoft-Christensen P., Baker M. J.: Structural reliability theory and its applications, Springer-Verlag 1982
2. Nowak, A.S., Collins K.R.: Reliability of structures. McGraw-Hill Higher Education 2000
3. Madsen H.O. Krenk S., Lind N.C.: Methods of structural safety. Prentice Hall 1986
4. Melchers R.E.: Structural reliability analysis and prediction. John Wiley & Sons 2001
5. Bucher Ch.: Computational Analysis of Randomness in Structural Mechanics. CRC 2009
6. Extensive research literature on the subject.