Course offered for the PhD program
in Civil, Chemical and Environmental Engineering
Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials
A.Y. 2023/2024 (XXXIX cycle)

(course is open for participation of students from other PhD cycles or programs)

1. Title
Model updating in structural dynamics

2. Course Description

This course is on the updating or calibration of finite element models. Although the focus will be on the updating based on experimental modal data (natural frequencies, mode shapes, modal strains, …), the concepts are readily applicable to any problem where experimental data from static or dynamic tests on structures are used to calibrate parameter values of a given structural model.

The course first illustrates the concept of finite element updating through a number of case studies where it is explained how the availability of modal data can be used to improve the predictive performance of finite element models in structural dynamics. Next, it is explained how the updating can be formulated as an optimization problem. Herein, the updating parameters are considered as design variables in an optimization problem where the objective function is a least-squares cost function that quantifies the difference between the experimentally identified and predicted modal data. The optimization problem is solved with a gradient-based method, where the gradient is either calculated analytically or approximated by finite differences. In this context, the difference between gradient-based optimization methods and heuristic stochastic methods is discussed. To familiarize the participants with the concept of finite element model updating, a number of simple problems are solved in Matlab. Finally, the concept of model calibration is extended to a Bayesian framework and it is explained how model and measurement uncertainty can be incorporated, with the aim of quantifying the resulting uncertainty on the identified parameter values.

Course prerequisites: Finite Element Analysis, Structural Dynamics

3. Course Organization
Lectures and exercises (Matlab needed)
In presence and online (upon request)

4. Teacher
Prof. Geert Lombaert (KU Leuven, Belgium)

5. Duration and credits
12 hours (2 CFU)

6. Activation mode and teaching period
Friday 12/04 until Thursday 18/04

7. Deadline for registration
Registration deadline: April 5th 2024.
To register, please send an email to geert.lombaert@kuleuven.be and federica.tubino@unige.it

8. Final exam
One homework assignment that addresses a problem of interest agreed between the student and Prof. Geert Lombaert