Dynamics of structures

Lecturer
Arnaud DERAEMAEKER (Coordinator)

Course mnemonic
CNST-H420

ECTS credits
4 credits

Language(s) of instruction
English

Course period
Second term

Campus
Solbosch

Course content

The course studies the time dependent behavior of constructions and buildings excited by dynamic forces.

The course starts with the analysis of systems with one, two and several degrees of freedom, with and without damping, and also deals with simple continuous structures (beams and bars).

The course continues with a short description of the different types of dynamic excitations including earthquakes, wind (including an introduction to self-excited vibrations and instabilities) and walking pedestrians.

The effects of these sources of excitations on civil engineering structures are discussed, together with modeling strategies including finite element models.

Design modifications and remedial measures are presented and illustrated for different case studies. A chapter is also dedicated to signal processing for experimental dynamics

Objectives (and/or specific learning outcomes)

The students will learn how to model time dependent dynamic behavior of structures. Emphasis is put on understanding the nature of the excitation and the ability to derive simple models from real complex structures and to compute their dynamic response due to different types of excitations.

The students will also develop a deep understanding of the effects of vibrations (positive or negative) on structures, and in particular resonance phenomena, and the possible design modifications and remedial measures.

Pre-requisits and co-requisits

Course having this one as pre-requisit

MEMO-H501 | Master thesis civil engineering | 24 crédits

Teaching method and learning activities

The course is articulated around different case studies for which the students will learn to describe the source of excitation, how to model the problem and predict vibration levels, as well as propose the most adequate design and remedial measures when these levels are excessive.

The course consists of 24h of lectures based on the principle of flipped classes. The students are asked to watch one or several short videos before the class, and the time in the class is dedicated to interactive activities such as wooclap sessions, group exercises and discussions

about case studies to consolidate the theoretical knowledge.

The following topics are covered:

1. Introduction

2. One degree of freedom systems

3. Sources of vibrations

4. Multiple Degree of Freedom systems

5. Finite elements models

6. Continuous Systems

7. Equivalent SDOF systems

8. Flow induced vibrations

9. Vibrations problems

10. Dynamic response computation

11. Design and remedial measures

12. Damping

13. Tuned vibration absorbers

14. Vibration isolation

The exercise sessions are organized in 6 sessions (24h) using Matlab or Octave, as well as the finite element code FinElg. The first two sessions are dedicated to understanding the basics of SDOF and MDOF systems, while the 4 remaining sessions are used for a project related to parasismic calculation according to Eurocode 8 and/or response to wind excitation (vortex induced vibration) applied to real civil engineering structures.

Contribution to the teaching profile

This teaching unit contributes to the following competences:

- In-depth knowledge and understanding of exact sciences with the specificity of their application to engineering
- Reformulate complex engineering problems in order to solve them (simplifying assumptions, reducing complexity)
- Correctly report on research or design results in the form of a technical report or in the form of a scientific paper
- Present and defend results in a scientifically sound way, using contemporary communication tools, for a national as well as for an international professional or lay audience
- Collaborate in a (multidisciplinary) team
- Combine computational modelling methods and experimental techniques to tackle complex structural and material analysis problems

References, bibliography and recommended reading

- H. Bachmann, Vibration problems in Structures, Birkhauser Verlag, 1995
- Inman, D.J - Engineering vibrations. Prentice Hall, 3d Edition, 2007 -Géradin M., Rixen D. Mechanical Vibrations - Theory and Application to Structural Dynamics. John Wiley & Sons, second edition, 1997

Course notes

Podcast and Syllabus

Other information

Place(s) of teaching

Solbosch

Contact(s)

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Evaluation method(s)

Oral examination and Project

Evaluation method(s) (additional information)

The evaluation consists in an oral examination as well as the evaluation of the project (oral presentation).

Determination of the mark (including the weighting of partial marks)

75% for the oral examination and 25% for the exercise sessions and project.

The presence at the exercise/project sessions is compulsory. The professor may refuse the participation to the oral examination in case of non justified absence at the exercise sessions.

Main language(s) of evaluation

English

Programmes

Programmes proposing this course at the Brussels School of Engineering

MA-IRCN | Master of science in Civil Engineering | finalité Professional/unit 1