UCLouvain

lgciv1023

2023

Structural Analysis

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Saraiva Esteves Pacheco De Alm João ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	Structural Mechanics (course LGCIV1031) and Strength of Material (course LGCIV1022)
Main themes	See "Content"
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 AA1.1, AA1.2, AA1.3, AA2.1, AA2.2 • Draw quickly, intuitively, and without calculations the distribution of internal forces in frame structures with corresponding main values, as well as the deformed configuration of statically-determined structures. • Determine the degree of static indeterminacy of a structure. • Solve statically determinate structures with the flexibility method, considering additionally the particular cases of variations of temperature, elastic supports, and imposed displacements. • Understand the concepts and application of the finite element method. Program a structural analysis code for 2D truss and frame structures, and compare with results from educational and commercial structural analysis software. • Understand the principles of structural dynamic behaviour. • Determine influence lines for statically determinate and indeterminate structures. • Analyse slabs with various boundary conditions
Evaluation methods	Final written exam. There will also be an optional written evaluation during the quadrimestre, which will address the same topic (Force method) as one problem of the final exam: the students can keep the best grade between this written evaluation and the corresponding exam problem. The use of generative artificial inteliggence (such as ChatGPT, Consensus, Perplexity, Bard...) is forbidden for the course.
Teaching methods	Lectures based on course slides and exercise solving with student participation.
Content	• Revision of strength of materials. • Statically determinate structures: computation of displacements with the unit dummy force method (Mohr's integration tables) and by integration of differential equations. • Statically determinate and indeterminate structures: external / global / internal indeterminacy. • Calculation of degree of static indeterminacy: intuitive and systematic approaches. • Flexibility (or force) method: primary system, static unknown(s), general solution procedure, compatibility equation, calculation of internal forces, computation of displacements (Pasternak's theorem). • Simplifications due to symmetry. • Statically indeterminate trusses. • Elastic supports: replacement method and adaptation method. • Thermal effects. • Imposed displacements and derivation of local stiffness matrix coefficients. • Stiffness (or displacement) method: degree of kinematic indeterminacy, free and restrained degrees of freedom, primary system, kinematic unknown(s), general solution procedure, equilibrium equation, calculation of internal forces. • Stiffness method *versus* Flexibility method. • Stiffness method (matrix form for computer implementation): global and local reference systems; beam and truss elements; disassembly and connectivity array; assembly, solution, and support reactions; properties of the stiffness matrix; condensation and beam with hinge element. • Finite element method: meshing, finite element, nodes, and types of finite elements; boundary conditions (kinematic and static); weak and strong formulations; Galerkin method, displacement and virtual displacement fields, interpolation functions; application to 2D beam element; general application examples. • Influence lines: statically determinate and indeterminate structures.
Inline resources	• Lecture slides (available on Moodle) and other files.

Bibliography	• Slides (Moodle). • « Calculer une structure, de la théorie à l'exemple », P. Latteur, Editions L'Harmattan/Academia. • « Analyse des structures et milieux continus », Volume 4 : Structures en barres et poutres, Pierino Lestuzzi et Léopold Pflug, Presses polytechniques et universitaires romandes. • « Méthode des éléments finis », Volume 6 : Analyse des structures et milieux continus, François Frey et Jaroslav Jirousek, Presses polytechniques et universitaires romandes.
Other infos	• For the matrix version of the stiffness method, the programming language Python will be used. • The educational software of structural analysis "issd" (www.issd.be) is an advised complement and its use during the exercise sessions will help to the understanding of the course contents.
Faculty or entity in charge	GC

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Bachelor in Engineering : Architecture	ARCH1BA	5		
Specialization track in Construction	FILGCE	5		
Minor in Construction	LMINOGCE	5		
Mineure Polytechnique	MINPOLY	5		