UCLouvain

lgciv1023

2020

Structural Analysis

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

5 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Saraiva Esteves Pacheco De Almeida João ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	*The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.*
Main themes	See "Content"
Aims	**Contribution of the course to the program objectives:** AA 1.1, AA 1.2, et AA 1.3 **At the end of this learning unit, the student is able to:** - Determine the degree of static indeterminacy of a structure and solve statically indeterminate structures with the flexibility method, considering additionally the particular cases of variations of temperature, elastic supports, and imposed displacements. - Identify the number of degrees of freedom of statically indeterminate structures and solve them manually with the stiffness method. - Draw the distribution of internal forces in frame structures with corresponding values, as well as the deformed configuration, of statically determinate and indeterminate structures. - Program a structural analysis code for 2D truss and frame structures, and compare with results from educational / commercial structural analysis software. - Understand the concepts and application of the finite element method. - Determine influence lines for statically determinate and indeterminate structures. 1 - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Group project (15%) and written final exam (85%). NOTE: These instructions take into account a "green" or "yellow" Covid scenario at UCLouvain. Modifications can be made in case of "orange" or "red" scenario, or restrictions in classroom capacities.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Lectures based on course slides and exercises solving with student participation. Group project.
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

Force majeure

Evaluation methods	30-minute oral exam (on the entire course content), corresponding to 85% of the final course grade. The weight of the group project is kept (15%).

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Minor in Construction	LMINOGCE	5		
Bachelor in Engineering : Architecture	ARCH1BA	5	LGCIV1031 AND LGCIV1022	
Minor in Engineering Sciences: Construction (only available for reenrolment)	MINGC	5		
Specialization track in Construction	FILGCE	5		